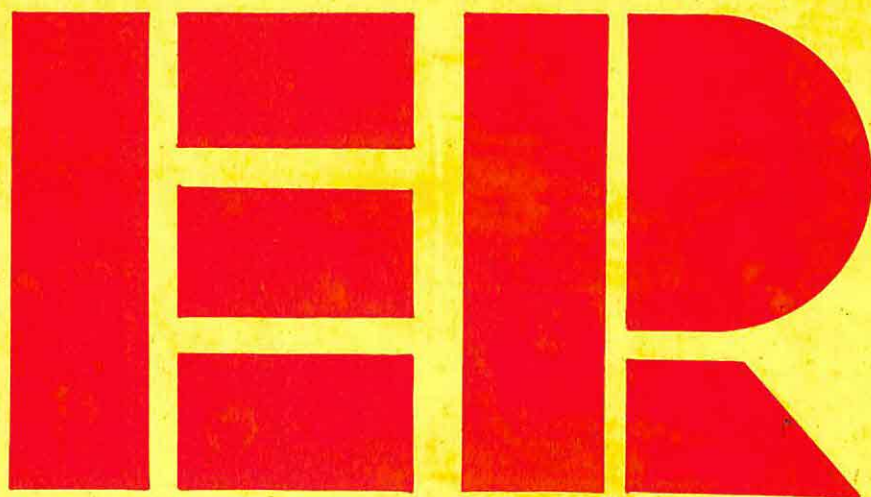




# **Educational Research**



**MOHD. SHARIF KHAN**

The book is divided into 24 Chapters. All the chapters have been written in very simple language. The author has attempted to make it very non-technical. The difficult concepts of educational research have been explained in such a way that those who try to understand through self-learning may also find it easy.

The first chapter deals with the meaning, purposes and characteristics of educational research. In the chapters 2 to 5, scientific methodology, inductive and deductive methods, variables and hypotheses have been discussed. In chapters 6 to 9, sampling techniques, stratified sampling, extraneous variables and sampling error have been discussed. The factors affecting significance levels, experimental and non-experimental research, experimental and control groups have been discussed in chapters 10 to 12. The factorial designs have been discussed in Chapters 13 to 14.

Various research methods have been presented in chapters 16 to 19. The research proposal, data collection, analysis and interpretation of data have been discussed in chapters 20 to 22. The research report has been dealt with in the last chapter.

This book is useful for all the students of M.Ed., and M.Phil in education. It is also useful for all the students of Social Sciences who propose to offer research methodology course or to do research at higher level.

# EDUCATIONAL RESEARCH



# Educational Research

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## Preface

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The author has felt during his several years teaching experience that students fail to understand the books written on Research methodology because generally they are written in technical language. Since this course is not taught before the Master's degree, the students are not familiar with its vocabulary, methodology and course contents.

The author has made an attempt to write it in very non-technical language. It has been attempted that students who try to understand the research methodology through self-learning may also find it easy. The first sixteen chapters have been written with that approach. The last eight chapters have been written with the usual traditional approach. Even those students who intend to attain high level of knowledge of the research methodology in education will find this book very helpful in understanding the basic concepts before they read any book on research methodology.

The book is useful for those students who offer the Research Methodology in Education at the M.Ed. or M.Phil. level.

I am thankful to Mr. Mohd. Asif Khan for typing the manuscript.

**Mohd. Sharif Khan**  
*Professor and Chairman*  
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*Aligarh.*

# Contents

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	Page
<i>Preface</i>	.. (v)
1. Meaning, Purposes and Characteristics of Educational Research	.. 1
2. Scientific Methodology	.. 8
3. Inductive and Deductive Methods	.. 15
4. Variables	.. 18
5. Hypotheses	.. 23
6. Sampling Techniques	.. 26
7. Stratified Sampling	.. 31
8. Extraneous Variables	.. 36
9. Sampling Error	.. 45
10. Factors Affecting Significance Levels	.. 53
11. Experimental and Non-Experimental Research	.. 58
12. Experimental and Control Groups	.. 62
13. Simple Randomized Design	.. 65
14. Simple Factorial Design	.. 70
15. Complex Factorial Design	.. 79
16. Introduction to Research Methods	.. 86
17. Historical Method	.. 91
18. Descriptive Survey Method	.. 96

19.	Experimental Method	..	110
20.	Educational Research Proposal	..	125
21.	Data Collection	..	138
22.	Data Analysis	..	143
23.	Interpretation of Data	..	149
24.	Research Report	..	153
	<i>Index</i>	..	160

# Meaning, Purposes and Characteristics of Educational Research

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## 1. Meaning

Research is an intellectual activity. It is responsible for bringing to light new knowledge. It is also responsible for correcting the present mistakes, removing existing misconceptions and adding new learnings to the existing fund of knowledge. Research is considered as a combination of those activities which are removed from day-today life and are pursued by those persons who are gifted in intellect and sincere in commitment of pursuit of knowledge. But it is not correct to say that the research is restricted to such type of persons. However, it is correct to say that major contribution of research comes from highly gifted and committed workers. Thus the research is not at all

mysterious and is carried on by hundreds of thousands of average individuals.

Research is also considered as the application of scientific method in solving the problems. It is a systematic, formal and intensive process of carrying on the scientific method of analysis. There are many ways of obtaining knowledge. They are intuition, revelation, authority, logical manipulation of basic assumptions, informed guesses, observation, reasoning by analogy. One of the branches of research known as empirical research is highly goal-oriented technique.

The following are the important definitions of "research".

- (a) "Research is an endeavour (attempt) to discover, develop and verify knowledge. It is an intellectual process that has develop over hundred of years ever changing in purpose and form and always researching of truth".

*(J. Francis Rummel)*

- (b) "Research is an honest, exhaustive intelligent searching for facts and their meanings or implications with reference to a given problem".

*(P.M. Cook)*

- (c) "Research is the process of development, elaboration and refinement of principles together with the Collection and use of empirical material to aid in this process is one of the highest activity of the University and one in which all Professors should be engaged".

*(Hutcheris)*

- (d) "Research is seeking through methodical processes to add to one's own body of knowledge and hopefully to that of others, by the discovery of non-trivial facts and insights"

*(Howard and Sharp)*

- (e) "Research may be defined as a method of studying problems whose solutions are to be derived partly or wholly from facts".

*(W.S. Monroes)*

- (f) "Research is simply a systematic and refined technique of thinking, employing specialized tools, instruments and procedures in order to obtain a more adequate solution of a problem that would be possible under ordinary means. It starts with a problem, collects data or facts, analyzes them critically and searches for decisions based on the actual evidence".

*(G.C. Crawford)*

The following are the important definitions of Educational Research :

- (a) "The systematic and scholarly application of the scientific method, interpreted in its broader sense, to the solution of educational problems; conversely any systematic study designed to promote the development of education as a science can be considered educational research".

*(Georg G. Monly)*

- (b) "Educational Research is that activity which is directed towards the development of a science of behaviour in educational situations. The ultimate aim of such a science is to provide knowledge that will permit the educator to achieve his goals by the most effective method".

*(Travers, M.W.)*

- (c) "Educational Research represents an activity directed towards the development of an organized body of scientific knowledge about the events with which the educators are concerned".

*(Travers, M.W.)*

- (d) Educational Research is to study "Causal" relationships. It is to describe current conditions without their being influenced by the investigator.

*(Sax, Gilbert)*

- (e) Educational Research is study and investigation in the field of education or bearing upon educational problems.

*(Good, C.V.)*

## 2. Purposes

The following are the main purposes of educational research :

- (i) to profit by the experiences of the past in the solution of present day educational problems.
- (ii) to develop the science of behaviour in educational situations.
- (iii) to provide knowledge that will permit the educator to achieve its goals by more effective method.
- (iv) to provide knowledge concerning achieving educational objectives.
- (v) to help the classrooms teacher to establish the conditions in the classrooms in order to achieve particular result.
- (vi) to follow an intensive process of scientific enquiry about philosophical, historical, economic, psychological and sociological impact on various aspects of education to establish sound educational theories.
- (vii) to find systematic solutions of educational problems so that the next generation is made free from tradition, ignorance and prejudice.
- (viii) to review existing knowledge.
- (ix) to describe some situation or problem.
- (x) to construct some situation.
- (xi) to provide understanding of contemporary educational problems.

### 3. Features

The following are the characteristic of educational research :

- (i) It develops new knowledge or data from Primary source.
- (ii) It develops general principles of a theory or a law.
- (iii) It is systematic, expert and accurate investigation about a particular problem.
- (iv) It strives to eliminate feeling, emotion, prejudice, favour and preference.
- (v) It may generalize even unpopular findings.
- (vi) It organizes data and quantity in qualitative term as far as possible and expresses them in numerical data.
- (vii) It requires an inter-disciplinary approach.
- (viii) It is not a field of specialist only Action research may be done by a classroom teacher or an educational administrator.
- (ix) It is not a purely mechanical approach.
- (x) Its methods are inadequate for the solution of many of the problems we face.
- (xi) It suffers from the inadequate of control.
- (xii) It continues to use criteria that would not survive critical and explicit discussion.
- (xiii) It is relatively prosaic, repetitive and lacking in impact.

## QUESTIONS

- (1) *What do you mean by research ? Give important definitions of research.*
- (2) *What do you mean by educational research ? Give important definitions of educational research.*

- 
- (3) *What are the main purposes of educational research ? Discuss them critically.*
- (4) *What are the main characteristics of educational research ? Discuss.*

## Scientific Methodology

---

### 1. Faith Vs. Scientific Methods

There is a great difference in faith or belief and scientific methods. The former-faith or belief is considered non-scientific. The common sense is also not scientific. There is no opportunity of making any experiment in faith and authority. The basic difference between faith or belief and scientific method is that while the faith or belief depends upon authority and tradition, the scientific method is objective because it depends upon evidence. But it has also to be admitted that we do not verify all statements. It is neither possible nor desirable. We accept the statements of those people in our daily life upon whom we have faith. We go to a doctor. He gives a diagnosis of our health. We accept it if we have faith in the doctor without any further

verification. However, the doctor can ask for some tests for verification of his diagnosis. Generally our actions are based on "hunches" or "intuition". Such behaviour depends on the appearance of what looks like the right approach. Generally intuitive approaches lead to trial and error behaviour which requires many trials and errors before the occurrence of satisfactory outcome. It is, therefore, correct to say that trial and error behaviour is inefficient. But there is a difficulty that we cannot know the best alternative before we take action. But if our approach is logical and experimental we can limit the range of alternatives even before we take action.

## 2. Devising Alternatives

It is not sufficient to limit alternatives. We must devise methods that permit us to verify objectively which alternative is the best. Trial and error is, no doubt, inefficient but it is better than merely acting on authority or faith because it helps in locating those alternatives which can be verified objectively. Suppose there is a statement "The best life is moral life". The question arises what is moral life. If we define it as that life in which there is lack of conflict with the law. Now this definition of moral life is more verifiable than moral life. This can be tested through an experiment. If the two groups are formed-one with the moral training. If other things being equal the group with moral training shows lack of conflict with the law while the other group shows it, it can be said that the supporting regarding the virtue of moral training was testable. But it is necessary to obtain objective evidence for making any judgement. However, it has to be admitted while laws made in natural sciences such as Physics and Chemistry are true

in every instance, the predictions made in behavioural sources are not always true but generally true. In behavioural sciences predictions are supported by facts but are generally not proved by them. They are made from the observation of many instances. Predictions of groups of people are more accurate than predictions made by an individual. Similary prediction of one instance is likely to be less accurate. Thus any probabilistic statement made by a specific individual in generally not true.

An example would clarify the matter. There is a prediction "Children with 100 I.Q. will have better performance in Mathematics than Children with I.Q. 90s. This statement will be generally true. If there is any child whose I.Q. is less than 100 but his performance in Mathematics is better than a child whose I.Q. is 102, we can say that the relationship between performance in Mathematics and I.Q. is less than unity.

### 3. Prediction Vs. Explanation

There is a difference between "prediction" and "explanation" in research. If we seek the cause for the better performance in Mathematics due to higher I.Q. it is called "explanation". If we confine our statement to "children with 100 I.Q. will have better performance in Mathematics than children with I.Q. 90s." We are making "prediction". Intuition and hunches are non-scientific explanations because they are non-scientific explanations. Seeking scientific explanations essentially involves objective verification of a cause or causes. But if the two events occur in sequence, it does not imply that one event is the cause of another event. But if it can be proved that the occurrence of an event requires the

earlier presence of some other event, than a "cause and effect" relationship can be presumed. But most of the behaviours are a result of multiple causes. Therefore, behavioural scientists are usually concerned with multiple causation. It is, therefore, suggested that the researcher should not think in terms of a single causal factor. Therefore, in the above mentioned example Intelligence may be a necessary factor in better performance in Mathematics but it is not sufficient cause. There are additional causal factor in better performance in Mathematics. Intelligence is partial cause for better performance. The factor of hard work and motivation may also be necessary causal factors. If any researcher tries to predict performance rates from a single antecedent, he is likely to be inaccurate in his prediction. Thus it can be safely said that in addition to "objective evidence", "explanation" is another purpose of scientific methodology.

#### 4. Methods of Obtaining Knowledge

(a) *Common Sense* : It refers to generally accepted information which is not correct. It may also refer to such information which is not only generally accepted but also it is verified empirically.

(b) *Appeal to Authority* : Generally if any view is presented about any issue and if it is supported by some authority in education it is accepted. For example if any point of view related to educational research is presented and the authority of Robert M.W. Travers or Caster V. good is quoted for it, it will be accepted as correct.

A.E. Mander in his book "Logic for the Millions" has

suggested four criteria for deciding whether the person may be considered an authority or not. They are :

- (i) The individual who is being judged as an authority should be identifiable.
- (ii) The person is recognized as an authority by the members of the profession concerned.
- (iii) The person should be living or his point of view should not have been rejected after death.
- (iv) The person should not be prejudiced or biased.

(c) *Intuition and Revelation* : Intuitive beliefs are “hunches” or “insights” into the relationships between variables which suggest a course of action and which are derived from one’s past experiences with similar phenomena. If they are put to empirical test, they may be found correct or incorrect. If they are found incorrect after empirical test they may not be accepted as knowledge.

Revelations are also considered “true” but they are conveyed from God to His messengers. Their source is outside human experience. They cannot be put to empirical test because they are considered the word of “God” which is source of all knowledge.

(d) *Rationalism* : It is a philosophic position that places person over both revelation and experience. The rationalists are of the view that concept such as God does not depend upon either experience or revelation but God can be proved if rational process is tried. It is called deductive process. Deduction is considered as reasonable way of deriving knowledge. The reasoning of

Mathematics is dependent upon rules of logic in which definitions of various terms and their inter-relationships are specified. The scientist also uses these rules and definitions to help derive relationships and specific conclusions. Thus deduction is useful but it is another matter to believe that it is the primary method for deriving all truth.

## 5. Characteristics of Science

The following are the characteristics of Science.

(a) *Reduction and control of bias* : Scientists are also human beings. They have also prejudices, biases and misinformation. The research wants that the scientist should work free of prejudice, and bias and should leave them when needed. Then only he can be called a researcher.

(b) *Quest for precision* : A distinction should be made between the scientists' desire for precision and accuracy and the quest for absolute knowledge. The scientist uses tools, techniques and methods to provide knowledge but knows that this knowledge is imperfect.

(c) *Verification* : The scientist knows that he can commit mistakes. He must allow other scientists to confirm or reject his conclusions. Similarly he examines evidences provided by other researchers.

(d) *Empiricism* : Empiricism emphasizes observation and experience and employs inductive reasoning as the prime means for establishing principles and generalizations.

(e) *Theory construction* : Some persons are of this opinion that the theory is the result of useless contemplation and as such deserves little consideration. Some persons are of this opinion that theory has value but it is not so important as practical knowledge. Neither raw observations make a science nor every accurate and organized thing makes science. On the other hand a scientific theory is a unified system of principles, definitions, postulates and observations organized to most simply explain the relationships among variables.

### QUESTIONS

- (1) *Explain the difference between faith and scientific method.*
- (2) *Explain the difference between prediction and explanation.*
- (3) *Describe different methods of obtaining knowledge*
- (4) *What are the characteristics of scientific method ? Discuss.*

## Inductive and Deductive Methods

---

### 1. Number of Observations

Observations are made to make generalisation. It is in the interest of the researcher that he should make as many observations as possible so that his generalisation may not be incorrect. A researcher cannot make generalisation on the basis of a single instance. It is also necessary that "observations" should not be by chance but they should "truly" represent the phenomena about what generalization is sought. "Generalisation" means that the events observed are representative of similar events which could have been observed. The statement "children with 100 I.Qs. will have better performance in Mathematics than children with 90 I.Qs." signifies a regularity between I.Q. scores and performance in Mathematics. Such a statement is a generalisation.

Generalisation which is arrived at from a number of observations of certain events is called inductive inference. It is useful for making predictions. But it has to be remembered that in educational research the accuracy of prediction based on inductive inference will be less than unity. If any inductive inference is made on the basis of one instance its validity will be low. It is, therefore, necessary that many observations should be made so that valid generalisation could be made. Thus it is the first requirements for valid generalisation that sufficient number of observations are made.

## 2. Representative Observations

The second requirement for valid generalisation is that sample of observations must be representative. It means that there should be no bias in the sampling of observations. Scientific methodology generally starts from the observation of particular events and arrives at a generalisation by the process of induction. In this process, the observer moves from the particular to the general. Its opposite process is moving from the general to the particular which is called process of deductive. For example Man is mortal. Mr. Yasin is a man; therefore Mr. Yasin is mortal. Those inferences which are made on the basis of logic are called deductions. The process of deduction consists of two premises. One of them is major premise and the other one is minor premise. If both the premises are true, the conclusion implied by the premises must be accepted as true. Research is designed to test the validity of predictions deduced from generalizations. It is not possible to demonstrate the absolute truth of generalization in educational research.

### 3. Use of Inductive and Deductive Process

The validity of a generalization increases with the increase of experimental instances. The usefulness of generalization depends to a great extent on one's being able to deduce inferences from them. If the inference which is deduced can be objectively verified it establishes the validity of a generalisation. In scientific methodology both inductive and deductive processes are used for inferences. The inductive process is from particulars to general and the deductive process is from general to particulars.

### QUESTIONS

- (1) *What do you mean by inductive method ? Discuss its relationship with number of observations.*
- (2) *What are the characteristics of representative observation ? Discuss.*
- (3) *Discuss the use of inductive and deductive methods in research.*

## Variables

---

### 1. Introduction

There are many concepts in which certain events are described but they are not useful for any explanation or prediction. Such concepts are not scientific and are of no use to a scientist. For an educational researcher those concepts are of particular interest which have some systematic relationship with any other concepts. They help in such relationship in making explanations as well as prediction.

Any concept can be expressed in quantitative value or qualitative value is called variable. In our example of chapter 2 the concept of intelligence can be expressed from Low to High. Thus intelligence can be termed in this example as one variable. Variables are concepts which serve a particular purpose in educational

research. If we are seeing the relationship on Intelligence and Scores in any school subject, both I.Q. and Scores are Variables.

## 2. Kinds of Variables

The variables may be continuous or non-continuous. For example, chronological age is an example of continuous variable. Similarly socio-economic status is an example of continuous variable. If we are categorising sex as male and female we are not having the continuous variable. Similarly if we compare the achievement of women with their size of hair, size of hair would be an example of non-continuous variable. Some variables are antecedent to other variables. If any student has to give good academic performance, it is necessary that he should have high order intelligence. In the example, the variable "intelligence" is antecedent to the variable "academic performance in Mathematics". If one of the variables is a result of another variable, the former is dependent upon the latter. In the above example academic performance is a consequence of the variable "intelligence". Academic performance is dependent upon the student's intelligence level. In educational research the variable which is a cause of antecedent variable is called dependent variable. In the above example Academic performance is a dependent variable.

Variable that is antecedent to the dependent variable is called independent variable. In the above example Intelligence is an independent variable.

Suppose students who are taught through discussion method have better academic achievement than those

who are taught through lecture method. In this example the dependent variable is achievement. Achievement is to be considered as the dependent variable because it is a consequence of the type of method of teaching. The type of method of teaching is the independent variable because it is antecedent to the academic achievement.

The dependent variable, academic achievement, is continuous whereas, the independent variable method of teaching is non-continuous.

In another statement "students who are under-achievers show a greater frequency of dropout than students who are over-achievers" the independent variable is level of achievement and the dependent variable is the frequency of dropout.

### **3. Effect of Independent Variable**

The educational researcher is concerned with the influence of independent variables on the responses of people. Responses of the people which are influenced by environmental conditions or antecedent behaviours are called dependent variables. The decision to manipulate the environment in a particular way is made antecedent to observing behavioural changes in people. The behavioural changes that occur as a result of the environmental manipulations are called dependent variables. Behaviours may be both independent and depending upon the example. However, environmental conditions or manipulations are always independent variables. Intelligence is a stable characteristic of an individual at a particular time, therefore, it is usually an independent variable. Similarly chronological age is also not affected by any procedure at a particular time, it is, therefore, always taken as an independent variable.

Assessing the effectiveness of the independent variable in bringing about changes in the dependent variable is the usual procedure for objectively verifying predictions.

#### 4. Organismic Variable

There are some variables which cannot be manipulated. They are accepted by the researcher as they are. They are levels of intelligence, sex, class levels, and the like. The researcher can classify the subjects by sex but he cannot modify to suit his research condition. If a researcher attempts to compare boys and girls on some learning task, any differences might be attributed to sex differences but not necessarily so. The differences between boys and girls could be due to differences in intelligence, training, motivation or a myriad of other conditions present in all human beings and not necessarily to biological differences between sexes. Those variables which cannot be manipulated and cannot themselves point out causal relations are called organismic variables.

#### 5. Extraneous Variable

Another type of variable is called extraneous variable. Any condition other than independent variable might be responsible for the effect on dependent variable. These conditions may be age, previous experience, intelligence, sex, socio-economic level, motivation, physical health, emotional problem, class atmosphere in administering the test etc. All of these conditions and more similar conditions must be controlled if the researcher wants to conclude that the independent

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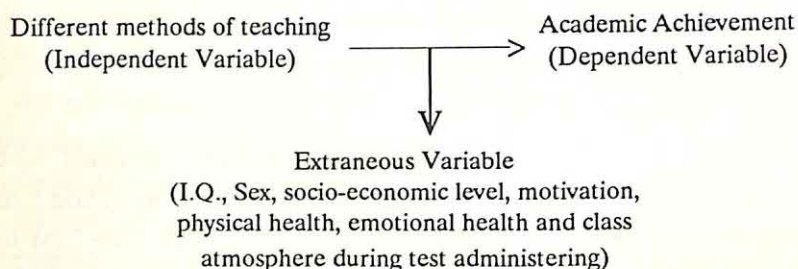
A.C.E.R.Y. West Bengal

Date

6.3.92



variable and not one of these extraneous variables were responsible for the impact upon dependent variable. The situation is further explained in the diagram.



## QUESTIONS

- (1) *What do you mean by variable in research? Give examples of variables in educational research.*
- (2) *What are different kinds of variable? Give examples of each in educational situation.*
- (3) *Explain the relationship of independent variable and dependent variable.*
- (4) *What do you mean by those variables which cannot be manipulated? Give their examples. Give the Technical terms for them in educational research.*
- (5) *What do we call that variable which has its effect upon dependent variable in addition to independent variable? Give some examples.*

## Hypotheses

---

### 1. Meaning of Hypothesis

“Children who are taught through text book method will learn more than children who are taught through lecture method”. This statement is a prediction. Prediction is hypothesized relationship. Therefore, prediction that is verified by scientific method is termed as research hypothesis. Each research hypothesis contains an independent variable and a dependent variable. A research hypothesis is a predictive statement that relates an independent variable to a dependent variable. If there is only one variable in any statement it cannot be called research hypothesis. Similarly if there are two dependent variables in any statement but there is no independent variable it also cannot be called a research hypothesis. If the predictive statement is of

such a nature that it cannot be objectively verified, it cannot be termed as research hypothesis. In the same way relationships that are assumed but they are verified cannot be called research hypotheses.

Let us take the following statement :

“In the first year of Type-Writing class students who are pointed out about their mistakes during typing practice will show better performance in Typing than those who are pointed out about their after typing practice.”

The above mentioned statement is a research hypothesis. The condition that is varied is the time of pointing out mistakes. The time of pointing out mistakes is independent variable. The performance in type-working is dependent variable. It may be assumed that the reason that the immediate pointing out of mistakes in typing is more effective than pointing out later on is because it increases motivation. But motivation is not to be verified explicitly and it is not treated as an independent or dependent variable. However if we could seek to verify objectively the relationship between motivation and time of pointing out mistakes, motivation would be dependent variable because it is dependent upon time of pointing out mistakes.

In order to verify objectively a research hypothesis it is necessary that both independent and dependent variables should be defined operationally. It is also necessary to specify the indicators of the variables to verify objectively the research hypothesis. One criterion of the adequacy of a research hypothesis is whatever it can be objectively verified. If a research hypothesis is testable, it is said to be verifiable.

## 2. Directional Vs. Non-directional Hypothesis

The hypothesis may be directional or non-directional. A research hypothesis which indicates the direction a comparison will take is termed a directional hypothesis. A research hypothesis which does not specify the direction of expected differences or relationships is called a non-directional research hypothesis. The example of directional hypothesis is as follows :

“Children who study in residential schools will show greater increases in social competence than those children who study in Day schools”.

The example of non-directional hypothesis is as follows :

“There will be a difference in the academic achievement of those who go through formal education and those who go through non-formal education”.

In the first example the hypothesis not only shows the difference in the two situations but also the direction of the difference. Thus it is called directional hypothesis. In the second example the hypothesis indicates the difference in the two situations but it does not indicate in which situation the academic achievement will be higher. Thus it is called non-directional hypothesis.

## QUESTIONS

- (1) *What do you mean by hypothesis? Give examples.*
- (2) *What do you mean by directional hypothesis and non-directional hypothesis? Give examples.*
- (3) *Give examples of research hypothesis and null hypothesis.*

## Sampling Techniques

---

### 1. Population

Educational Researcher can collect information from all the students about whom he wants to do the research. If he collects information about all the students, he will have data on the total "population". "Population" is a technical term in research. It is determined by defining characteristics. When the researcher obtains measures of all individuals who have these defining characteristics, he has measured the population. For example if the defining characteristics of a population are boys, a girl would not be an element of the population. Similarly if the defining characteristics of a population are class X students, a student in class IX would not be element of the population. If the population is small, it is possible to collect the required

---

information from all. If the population is large, it would not be possible to collect the required information from each and every one.

## 2. Sample

In such a situation the researcher may sample the population. If a portion of a population is taken with the defining characteristics, it will be said that a sample of the population has been taken. A sample should reflect the characteristics which define the population from which it was selected. The purpose of research is to generalize about the behaviour of a population. Since educational research is generally done on a large size of population, it is necessary to select a sample in order to generalize for the population.

If the sample is not properly taken from the population, there is a fear that generalization may be inaccurate. It is, therefore, necessary that a representative sample should be obtained. Usually the larger the sample, the more likely it is to be representative of the population. The most simple technique for obtaining a representative sample is random selection. If a sample is not randomly selected, it is not likely to be representative of the population. For example the students of any particular class of a Public School cannot be representative of the students of that class of a regular school. The reason is the selective factors that was responsible for admission to a public school. It is, therefore, not desirable to generalize for a regular school on the basis of a public school. If a sample is not randomly selected, the chances that it is representative of the population are greatly reduced. The question arises what is the requirement of random

selection. It is necessary for random selection that every element in the population must have an equal opportunity of being selected. If any element of a population is denied equal chance of being selected, the sample becomes biased. For example if we generalize about the students of any particular class of ordinary school on the sample of public school, it will be an example of a biased sample. A biased sample decreases the accuracy of generalization about population.

### 3. Random Sampling

In order to obtain random selection the researcher should use a table of Random Numbers. It is first necessary to assign a number to every element in the population. Then the researcher should make a random selection from the array of numbers.

A Table of Random Numbers is given below :

TABLE : Random Numbers

Row	Column Number
1	2
	00000
	01234
00	23157
01	05545
02	14871
03	38976
04	97312
05	11742
06	43361
07	93806
08	49540
09	36768
10	07092
11	43310

1	2
12	61570
13	31352
14	57048
15	09243
16	97957
17	93732
18	72621
19	61020
20	97839
21	89160
22	25966
23	81443
24	11322
25	64755
26	10302
27	71017
28	60012
29	37330
30	47869
31	38040
32	73508

The researcher can start any where and move in any direction for random selection. Suppose there is a population of 60 children and the researcher wishes to select a sample of 10 children from this population. This can be done through use of a table of Random Numbers. The researcher should assign a number to each child in the population. In the present example the numbers will be from 1 to 60. The researcher is concerned with only two-digit numbers, will use two digits in the table of Random selection. The following rules will be observed :

- (1) The researcher can enter the table any where
- (2) He can move in any direction
- (3) The numbers which are larger than the population will be ignored

- (4) If a number has been selected and appears again in the table, it cannot be selected again.

In the above mentioned example the 10 children selected would be selected as follows :

23, 05, 14, 38, 11, 43, 49, 36, 07, and 31.

All the numbers have been selected from the table of Random Numbers without any bias 97 has been ignored because there are only 60 children 43 has been ignored because it has already been selected. 61 has been ignored because there are only 60 children.

Thus the sample of children has been randomly selected and is a representative sample.

### QUESTIONS

- (1) *What do you mean by "Population" in research? Give examples from educational research.*
- (2) *What do you mean by "sample" in research? Give examples from educational research.*
- (3) *What do you mean by random sampling?*
- (4) *What is random numbers table? What are the rules which are observe in random number table?*
- (5) *Suppose there is a population of 5000 children. The researcher is required to select a sample of 100 children. Write the numbers of children which will be selected from the population. Using the table.*

## Stratified Sampling

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### 1. Meaning

We have in the previous chapter about the random selection of a sample. It was done to make the sample, a representative sample. There is another way of obtaining the representative sample. The researcher, in that method, can select the elements in proportion to their occurrence in the population. If the sample is obtained in this way, it is called stratified sample. The stratification may be done on the basis of age, socio-economic status, sex, intelligence etc. Each element is called strata. In stratified sampling, the population is divided into a number of strata which must be mutually exclusive. It is also necessary the elements should be randomly selected to insure maximal representativeness

within a strata. Examples of stratified population are given below :

**Stratification of teachers on the basis of age**

<i>Age</i>	<i>F</i>
21 - 25	10
26 - 30	60
31 - 35	80
36 - 40	50
41 - 45	40
46 - 50	20

---

N = 260

---

There are 6 strata of age in the population. If the researcher wanted to select 20% sample from this population, the size of the sample will be 52. In the sample the researcher will take 20% of the cases in each stratum. For a 20% sample, the researcher must select 2, 12, 16, 10, 8 and 4 cases respectively from the sex strata of age.

## **2. Procedure**

The stratification of population helps in determining how many elements should be sampled from each stratum. To make the sample representative the elements within each stratum must be selected randomly. On the other hand if the researcher wishes to obtain a sample of 100 teachers he must select 38.46 percent of this population. Thus the researcher may obtain a stratified sample of a population by

determining either the percentage of the population or the sample size. This stratification of population was done on the basis of one characteristic only i.e. age. It is possible to obtain stratification of population on more than one characteristic.

Suppose the researcher feels that the opinion of male teachers and female teachers may differ in the above mentioned example in addition to their differences on the basis of age. In order to obtain proper representation of male teachers and female teachers within each age stratum, the researcher should obtain a stratified sample. He should stratify the population on both the teachers' sex and age.

The distribution of male teachers and female teachers is as follows :

TABLE : Stratification of Population of Teachers

Age	Male Teachers	Female Teachers	Total
21 - 25	3	7	10
26 - 30	40	20	60
31 - 35	50	30	80
36 - 40	34	16	50
41 - 45	28	12	40
46 - 50	18	2	20
	173	87	260

If 20% of the teachers are to be taken in the sample the stratified grouping would be as follows in the sample :

TABLE : Stratification of the Sample of Teachers

<i>Age</i>	<i>Male Teachers</i>	<i>Female Teachers</i>	<i>Total</i>
21 - 25	1	1	2
26 - 30	8	4	12
31 - 35	10	6	16
36 - 40	7	3	10
41 - 45	6	2	8
46 - 50	3	1	4
	35	17	52

In order to insure that his sample is representative, the researcher must randomly select students within each stratum.

Whenever a population is stratified on any characteristic e.g. age, intelligence, socio-economic status or sex etc., the elements within each stratum are more homogeneous than are the elements within the total population. Suppose intelligence and academic achievement in any school subject are moderately correlated within a given population. In the present example the more intelligent children would have better academic achievement also. If the researcher stratifies the population on the characteristic of intelligence, he is to some degree also stratify it on the characteristic of academic achievement. If the researcher stratifies population on intelligence, the individuals within each stratum of intelligence would be more homogeneous with respect to this characteristic than would be the elements within the population. Beside this if intelligence and academic achievement are moderately correlated, stratification on the characteristic of

intelligence would make the individuals homogeneous on academic achievement within each stratum. If the two characteristics are having + 1 correlation in the population, stratification on one characteristics would lead to + 1 correlation on the other characteristic. If two characteristics are having moderate correlation, stratification on one characteristic will not lead to perfect stratification on the other characteristic but stratification on one will have the effect of reducing the heterogeneity of the second characteristic within each stratum.

Thus the stratification of population on one characteristic will result into stratification on the other characteristic.

### QUESTIONS

- (1) *What do you mean by stratified sampling?*
- (2) *Describe the procedure of stratification in educational research.*
- (3) *What are the characteristics upon which population is stratified?*

## Extraneous Variables

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### 1. Meaning

The researcher tries to perceive the effect of independent variable on the dependent variable but it generally happens that the dependent variable is related to some other variable. Such independent variables which are related to the purpose of the study are called extraneous variables if they have their effect upon the dependent variable. The researcher may design his study in such a way that the dependent variable is attributed solely to the independent variable and not to some extraneous variable. It is one of the requirements of a good research design that the effect of extraneous variable is minimized. The technical term "Control" is used to minimize the effects of extraneous independent variable.

Let us take a hypothesis for further explanation.

“Students taught through text book method (group A) show greater gains in academic achievement than those children taught through Lecture method (group B)”.

In the above hypothesis, the method of teaching is independent variable, the academic achievement is dependent variable and because intelligence affects the academic achievement, it is an extraneous variable. Since the researcher is interested in assessing the effect of teaching method on academic achievement, he would need to control for the variable of “intelligence”. One way of controlling for the variable of intelligence is to obtain two groups who are not made comparable on intelligence, the relationship between the method of teaching and the academic achievement would not be clear. It is said to be confounded by the extraneous variable. Confounding can be eliminated by controlling the effect of extraneous variables. If students are assigned randomly to group A and group B, it is likely that the two group would be comparable on most variables. Thus at the beginning of the study, the two randomly assigned groups are likely to be comparable on the dependent variable of academic achievement. Thus by random selection of students, the two groups are likely to be comparable on such extraneous variables as intelligence and the extraneous variable intelligence is controlled from its effect. If the two groups are comparable on intelligence but even then there is difference in the academic achievement if the two groups through two methods of teaching, the gains are not due to the variable of intelligence. Since there may be other extraneous variables also, the researcher should select a large enough sample so that all

extraneous variables could be controlled. The process of randomization reduces the effect of extraneous variable on the study. If the nature of the study is such that extraneous variable cannot be controlled by randomization, there are statistical techniques which permit the assessment of the effect of the independent variable on the dependent variable taking into account the effect of extraneous variable.

## 2. Control

The researcher generally works with the groups which have been already working and he has no choice of randomization and assignment to groups. Then some other methods are to be found to control the effects of extraneous variable. In research "Control" does not mean complete elimination of effects of extraneous variable. It in research means that groups are made comparable on one or more extraneous variables. It will decrease the differential effects of such variables on the groups. Controlling of an extraneous variable will not remove the correlation between it and the dependent variable. It would make the groups comparable on this variable. If the two groups which are being taught by two different methods are controlled for intelligence, the two groups are made comparable on intelligence. It does not mean that intelligence will not affect the dependent variable. For example if the correlation between the intelligence and academic achievement is positive, and the intelligence is controlled, the correlation between intelligence and academic achievement would not be eliminated. But if intelligence is controlled, this extraneous variable would not have a differential effect on academic achievement for the groups being compared. Besides randomization, another method

which makes the groups comparable, is to select samples which are as homogeneous as possible on extraneous variable. The groups if cannot be made completely comparable on intelligence, the range of variation of Intelligence can be restricted. It would make the groups more homogeneous on intelligence. For example instead of selecting children from I.Q. range of 90-140 if population is restricted to children with I.Q's between 115 and 135, the effect of I.Q. within this group on the dependent variable would be small. It can be further reduced by making the range between 120 to 130. If all the children of identical I.Q. score are taken in population, the maximum control of Intelligence variable is obtained on the dependent variable. This is true not only for Intelligence as extraneous variable but for all those extraneous variables whose score can be increased or decreased. Similarly if all the children of the same age are selected, it means that the age as extraneous variable has been controlled.

### 3. Homogeneity

But it should be remembered that the generalization of restricted range group or homogeneous group cannot be made beyond the limit of the range or of homogeneity. Thus selecting a sample from a homogeneous population decreases the generalisation of the research findings.

Let us see the following example :

TABLE : Mean Academic Achievement Scores

I.Q. Strata	Lecture Method		Text book Method	
	Boys	Girls	Boys	Girls
High	61	61	60	62
Middle	55	53	53	52
Low	33	25	44	36

The above example presents the mean Academic Achievement scores for a sample which has been stratified by intelligence and sex for each teaching method. It is clear that regardless of the teaching method or sex of the children the mean Academic Achievement Scores are related to the children's intelligence. For high I.Q. males, the two teaching methods are equally effective. It can also be concluded that both teaching methods are equally effective for high I.Q. boys as well as girls. It is also evident that both methods of teaching for the middle I.Q. stratum are equally effective regardless of sex but for the low I.Q. stratum, the effectiveness of the two teaching methods appears to be different. As far as low I.Q. stratum is concerned, there is difference in the effectiveness of the two teaching methods based on the sex of the children. The stratification of the sample for sex and intelligence has increased the definiteness of the findings.

Another method of controlling the extraneous variable is to match children so that each pair of children is as comparable as possible. It needs identification of pairs of children who are highly similar on the variable to be controlled. If the two children whose average of the marks obtained in different subjects in Secondary School Examination is 62 can be said to be matched on academic achievement.

Let us take the example of the children who will be taught either through lecture method or through text book method and write them in rank orders on the variable of average of the marks obtained in different subjects in Secondary School Examination.

<i>Text book Method</i>	<i>Lecture method</i>	<i>Student No.</i>	<i>Average Marks in the School Subjects in Secondary School Exami- nation</i>
	←	1	66
←		2	65
	←	3	64
←		4	63
	←	5	62
←		6	61
	←	7	60
←		8	59
	←	9	58
←		10	57
	←	11	55
←		12	53
	←	13	50
←		14	47
	←	15	45
←		16	40
	←	17	38
←		18	35
	←	19	33
←		20	30
	←	21	27
←		22	24
	←	23	20
←		24	18
	←	25	15
←		26	12
	←	27	10
←		28	10
	←	29	9
←		30	8

The above example contains the average Mark in School Subjects of 30 randomly selected Secondary School Examination students. One limitation on the generalization of the findings is that all of the students are of Secondary School Examination. Since the students have been randomly selected they are representative of students of Secondary School Examination from a particular Secondary School. They have been written in rank order on the variable of average mark in the School Subjects in Secondary School Examination, the highest mark at the top and the lowest at the bottom. The students No. 1 and No. 2 make the first pair. The average marks of the first pair are 66 and 65. Student No. 1 will be assigned to Lecture method and Student No. 2 to text book method. It would be the best to assign the students from each matched pair to Lecture method and text book method. In the above example the assignment has been done systematically. The odd numbered students have been assigned to Lecture method and even numbered students to text book method. The assignment of Student No. 1 to either method was done by head-tail of the coin. The Average mark in the School Subjects in Secondary School Examination of the two groups (Text book method group and Lecture method group) is comparable because they are relatively similar. But the second score in each matched pair is some what lower than the first score. The mean of the average mark in School Subjects in Secondary School Examination of the students in the text book method is lower than those in the Lecture method group. It makes the grouping biased. It can be corrected by having the first student of each succeeding matched pair assigned alternatively to text book method and Lecture method.

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TABLE : Procedure

Procedure I				Procedure II			
Student No.	Lecture method	Student No.	Text book method	Student No.	Lecture method	Student No.	Text book method
	Average marks in the school subjects		Average marks in the school subjects		Average marks in the school subjects		Average marks in the school subjects
1	66	2	65	1	66	2	65
3	64	4	63	4	63	3	64
5	62	6	61	5	62	6	61
7	60	8	59	8	59	7	60
9	58	10	57	9	58	10	57
11	55	12	53	12	53	11	55
13	50	14	47	13	50	14	47
15	45	16	40	16	40	15	45
17	38	18	35	17	38	18	35
19	33	20	30	20	30	19	33
21	27	22	24	21	27	22	24
23	20	24	18	24	18	23	20
25	15	26	12	25	15	26	12
27	10	28	10	28	10	27	10
29	9	30	8	29	9	30	8
Total	612		582		598		596

#### 4. Procedure

If the first student of each pair is alternatively assigned, the students in lecture method would be 1, 4, 5, 8, 9, 12, 13, 16, 17, 20, 21, 24, 25, 28 and 29 and the students in the text book method would be 2, 3, 6, 7, 10, 11, 14, 15, 18, 19, 22, 23, 26, 27, and 30.

Thus the assignment of the students through the first procedure and second procedure to the two groups the groups will be seen in the Table.

The total of Lecture method under Procedure I is 612 and under Procedure II is 598. The total of text method under Procedure I is 582 and under Procedure II 596. It shows that the two groups are more matched under Procedure II than under Procedure I because while in the former case the difference is of 2 marks and in the latter case the difference is of 30 marks.

Any systematic bias can be eliminated by randomly assigning students from each matched pair to text book method and Lecture method but it will be more eliminated under the second procedure than under Procedure I.

Thus it can be said that extraneous variables can be controlled by randomization, by homogeneity and by matching.

#### QUESTIONS

- (1) *What do you mean by extraneous variables? Give examples from a hypothesis.*
- (2) *How does the educational researcher control the extraneous variable?*
- (3) *What are the methods of controlling extraneous variable? Write their procedure.*

## Sampling Error

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### 1. Introduction

We have seen in the earlier chapter that due to large size of "population" the research hypotheses are generally tested on a sample rather than whole population. It was also pointed out that the sample should be representative of the population otherwise conclusions may not be valid. The method which is generally selected for this purpose is known as random sampling but it also does not guarantee that the sample will exactly represent the population. It is also not necessary that the mean score of the samples would agree with the mean score of the population.

Let us take an example for explanation :

Population	(N)	=	4,000
Mean Score	(X)	=	100

Suppose four samples are taken from this population.

Sample No. 1	=	50	Mean Score	=	95
Sample No. 2	=	50	Mean Score	=	102
Sample No. 3	=	50	Mean Score	=	101
Sample No. 4	=	50	Mean Score	=	98

The above mentioned example shows that the mean score of 4000 population is 100 and the mean scores of the samples No. 1, No. 2, No. 3, and No. 4 are 95, 102, 101 and 98 respectively. The mean score of sample No. 1 is smaller than the population mean score. The mean score of sample No. 2 is bigger than the mean score of the population. Although both the samples have been randomly selected the mean score of these samples differ from the mean score of the population. In the above example the mean score of the four samples differ from the population mean score. Since all the mean scores of the 4 samples are different from the population mean there is some error in the mean scores of the samples. This mistake is due to chance error in selecting samples and it is termed as "Sampling Error". Thus the researcher can never be certain that a sample mean score reflects the population mean score exactly on account of sampling error. However it should be close to the mean score of the population provided proper sampling techniques have been used in the selection of sample.

## 2. Statistical Inference

Suppose a teacher of Type-writing wishes to examine the hypothesis that the Type-writing accuracy of class X female students is greater than the accuracy of class X

male students. The teacher randomly selects a sample of female students and measures their accuracy. The accuracy score of the girls' is 30 and the boys' is 29. If on the basis of this score the teacher generalizes that class X girls score is higher than class X boys, the generalization would not be justified because it is possible that this difference was due to sampling error. The statistical techniques are available through which it could be determined whether the difference was true difference on the population or it was due to sampling error. If statistical techniques is employed to determine the probability that an inference regarding a population is correct, it is said that the researcher is making "Statistical Inference". The researcher is generally concerned with determining probability levels associated with hypotheses. The statement "girls are more accurate in Type-writing than boys" is a hypothesis. The data for two samples drawn from the population of class X is already available. The teacher of Type-writing wishes to determine the probability level that the hypothesis is correct. He can do it by employing statistical techniques. The statistical techniques permit to calculate the probability that two samples come from the same population. The research hypothesis mentioned above states that the scores of the girls and boys come from different populations of Type-writing scores. Thus this research hypothesis is concerned with two populations scores. Statistical techniques cannot be used to examine whether the two samples are from different populations. They can only be used to determine the probability that samples are from the same population. The research hypothesis is stated in terms of more than one population. It should be rewarded so that it is concerned with the scores of one

population then only it can be statistically examined.

If it is rewarded as a null hypothesis it can be as follows :

“There is no difference in Type-writing scores of boys and girls”.

The null hypothesis assumes that both the samples are selected from the same population and statistical techniques can be employed. If the means of two samples are not different, it can be inferred that both of them are from the same population. It has been already seen that the mean scores of two samples of same population are generally not exactly the same on account of sampling error. The statistical techniques are available through which it can be determined whether the difference is due to sampling error.

If the researcher concludes that the difference between sample means is due to sampling error, he is justified in accepting the null hypothesis. The rejection of the null hypothesis means that the samples do not come from the same population. If it is the conclusion of the researcher that the samples are from the same population, it means that the samples are from the same population, it means that the difference between sample means is due to sampling error. The statistical techniques can help in determining the probability that the two samples are from the same population. Thus the researcher obtains the probability that null hypotheses is correct with the use of statistical techniques. If researcher through a statistical test comes to the conclusion that there is a 98% probability that the null hypothesis correct, he is justified in accepting the null hypothesis. The null hypotheses can be rejected only where there is a very low probability that it is correct.

### 3. Probability Level

In educational research, the probability is usually written in decimal form. The "P" is used as symbol for probability. For example, the expression  $P = .25$  is read as "the probability is equal to 25%." We can also say it as "there are 25 chances in 100." If there is a probability of  $P = .05$  or less that sample differences due to sampling error, the researcher will reject the null hypothesis. The symbol  $<$  means less than. The expression " $P .05$ " is read as the probability is less than .05. On the other hand, the symbol  $>$  means "greater than". The expression, "The probability is greater than .05 would be written  $P > .05$ ." The educational researcher generally rejects the null hypothesis if the probability is  $P .05$ . It can be said that the educational researcher generally rejects the null hypothesis if the probability is greater than .05.

For example an educational researcher administers a test to study the difference in academic achievement of two samples of students and obtains the following data :

Sample No. 1 =	mean score	72
Sample No. 2 =	mean score	69

The researcher performs a statistical test and determined that the probability of the null hypotheses being correct comes  $P = .16$ .

In the above example the mean difference between two sample is 3 points. The two samples come from the same population because the null hypothesis is there. Since the educational researcher rejects the hypothesis at the highest probability level of .05 and in the present study it is .16, the researcher should accept the null

hypothesis. In other words, it can be said that the probability level of  $P = .16$  was too large a probability to permit the researcher to reject the null hypothesis.

Some educational researchers reject the hypothesis at the highest probability level .01. Such researchers are more confident in making decision about accepting or rejecting the null hypothesis than those researchers who accept probability level .05.

Let us take an example :

Suppose in the above mentioned example the data is as follows :

Sample No. 1 = mean score 50

Sample No. 2 = mean score 38

The statistical analysis of these data yields a probability level of  $P = .02$ .

In this example the mean difference between two samples is 12 points. The null hypothesis means that the obtained 12 point difference between two classes is due to sampling error. If the researcher chooses  $P = .01$  as his probability level for rejecting the null hypothesis, he would have accepted the null hypothesis because his obtained probability was greater than  $P = .01$ .

On the other hand, if the educational researcher would have rejected the null hypothesis at the highest probability level .05, the researcher would have rejected the null hypothesis because the obtained probability of .02 was lesser than  $P = .01$ .

Thus the rejection of the null hypothesis depends upon the probability level also. All the hypotheses which are rejected at .05 level would be rejected at .01 level but it is possible that those hypotheses which are rejected at .05 level may not be rejected at .01 level.

It is, therefore, necessary that the researcher should

decide the probability level at which he will reject the null hypothesis before he begins his research work. The probability level which the research decides to use in his research work is called level for significance. Thus if the conclusion of the researcher is "There was a significant difference between the sample means" it means that the null hypothesis is rejected.

But this fact is to be admitted while the researcher uses population he can make conclusions with certainty. On the other hand if he uses "Sample" for research study he cannot conclude with absolute certainty.

There are two types of error which a researcher can commit while accepting or rejecting the null hypothesis. They are as follows.

#### 4. Types of Sampling Error

*Type I Error* : The researcher rejects the null hypothesis using sample data when the samples are from the same population.

*Type II Error* : The researcher accepts the null hypothesis using sample data when the samples are from different populations.

If the researcher rejects a null hypothesis using a statistical test of sample data, there is always some probability that the researcher has made a Type I error because the difference he obtained may be due to sampling error. If he designates  $P = .05$  as the level at which he will reject the null hypothesis, the probability that he will make a Type I error is only  $P = .05$ . If on the other hand he designates  $P = .01$  as the level at which he will reject the null hypothesis the probability that he will make a Type I error is only  $P = .01$ .

The lower the level the researcher designates for rejecting the null hypothesis, the smaller the probability of making a Type I error. The lower the level the researcher designates for rejecting the null hypothesis, the greater the probability of making a Type II error.

### QUESTIONS

- (1) *What do you mean by sampling error? Give examples.*
- (2) *What is statistical inference? Give examples.*
- (3) *What is probability level? What is the difference between two probability levels which are generally used in educational research?*
- (4) *What are the types of sampling errors? Give examples.*

## Factors Affecting Significance Levels

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### 1. Introduction

We have learnt in the earlier chapter that a researcher can determine the probability that the difference between two sample means is due to sampling error by applying statistical technique such probability level is called the significance level. The significance level is expressed in terms of certain percentage. For example if the researcher says that the difference between two sample means is "significant at .01 level" it means "the probability level that the difference between the sample means is due to sampling error is  $P = .01$  or  $P = 1\%$ ."

The low probability levels are considered more significant than high probability levels. For example if the researcher's statistical analyses of the data yielded a probability level of  $P = .08$ , it is more significant than if

it yielded a probability level of  $P = .02$ . Thus generally the large difference between sample means are more significant than small differences because small differences are likely to be within the limit of sampling error while the large difference are likely to be beyond the limit of sampling error.

## 2. Factors

The question arises what are the factors which are responsible for making a difference between sample means significant. The first factor is the magnitude of the difference between the means of the two samples. For example if there is a difference of 15 points in two means in one case and is of 20 points in the other case, the latter case will be more significant than the former case *because of the magnitude of difference between two means.*

The second factor which is responsible for making a difference between sample means significant is size of the samples. For example if the size of the samples in one case is 100 and is 80 in the other case, the former is likely to be more significant than the latter. It stands to reason that if the researcher has used proper sampling techniques, large samples are more representative of a population than small samples. The largeness of the samples makes them more representative of the population which reduces the chances that the mean difference is due to sampling error.

Suppose an educational researcher obtains the following data :

### *1-2 Comparisons*

Sample 1	N = 100	Mean Score = 35
Sample 2	N = 100	Mean Score = 45

*3-4 Comparisons*

Sample 3	N = 50	Mean Score = 35
Sample 4	N = 50	Mean Score = 45

In the above example the difference between the means of Samples 1-2 is the same as the difference between Samples 3-4 but the number of individuals in Samples 1-2 is larger than in samples 3-4. In other words the size of the difference of the samples 1-2 is larger than of the samples 3-4. If a statistical test of the difference between samples 1 and 2, is applied it will yield a higher significance level than if it is applied to samples 3 and 4 on account of the size of the samples.

The third factor which is its effect upon the *significance level* is the *variability of the scores within each sample*. *If there is a high degree of variability among the scores within each sample, it can be assumed* reasonably that the difference between the means of sample which is due to sampling error will be larger than if we scores within each sample have little variability. In other words it can be said that homogeneity of the scores in each sample is likely to yield a smaller difference due to sampling error between sample means.

Let us take an example.

Suppose the researcher obtains the following data :

*1-2 Comparisons*

Sample 1	N = 100	Mean Score = 35	SD = 6
Sample 2	N = 100	Mean Score = 45	SD = 6

### *3-4 Comparisons*

Sample 3     $N = 100$         Mean Score = 35        SD = 8

Sample 4     $N = 100$         Mean Score = 45        SD = 8

In the above example, the difference between the means of samples 1 and 2 is the same as the difference between the means of samples 3 and 4. Similarly the number of cases of each sample in 1-2 comparison is the same as the number of case of each sample in the 3-4 comparison. But there is more variation within the samples in the 3-4 comparison because while it is 6 in 1-2 comparison, it is 8 in 3-4 comparison. If other factors remain the same, the difference between the means is more likely due to sampling error in 3-4 comparison because there is more variability within the sample in 3-4 comparison.

Generally a statistical test of the difference between sample 1 and 2 will yield a higher significance level than the difference between samples 3 and 4. If other factors remain the same, the same magnitude of difference between the means of homogenous sample will be more significant than it will be for heterogeneous samples and the less variability among scores within the samples the more significant will be the difference between their mean scores.

The fourth factor which affects the significance level is whether the research hypothesis is directional or non-directional. A directional hypothesis one which predicts the direction of the difference between mean scores. If the researcher states the research hypothesis non-directional one, he will reject the null hypothesis if the obtained difference between sample means is sufficiently large, regardless of the direction of the

difference. The researcher can reject the directional hypothesis only if the difference is in the hypothesized direction. When an educational researcher states a directional hypothesis, he is concerned with determining if sample means differ significantly only in the predicted direction. He evaluates the significance of the difference between sample means regardless of the direction when he states a non-directional hypothesis. The statistical tests yield higher significance levels for the difference between sample means if the research hypothesis is directional rather than non-directional. Thus it is to the researcher's advantage to state a directional hypothesis if he has some basis for so doing. If the null hypothesis is based upon a non-directional research hypothesis a given difference between sample means will be less significant than if it is based upon directional hypothesis.

Thus these are the following factors which affect the significance level.

- (1) The magnitude of the difference between sample means.
- (2) The size of the samples.
- (3) The variability of the scores within the samples.
- (4) Whether the research hypothesis is directional or non-directional.

## QUESTIONS

- (1) *What are the factors which are responsible for making a difference between sample means significant? Discuss.*
- (2) *What is the significant of determining the level at .01 and .05? Discuss.*

## **Experimental and Non-Experimental Research**

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### **1. Introduction**

You have read in an earlier chapter that there are independent variable and dependent variable in any hypothesis. The independent variable may be of such nature that it can be manipulated in some cases while it may not be manipulated in other cases.

### **2. Non-experimental Research**

Take an example if an educational researcher was interested to find out whether the socio-economic status affected the academic achievement for a group of class X students. The researcher selected 200 students and tested their academic achievement and found out their socio-economic status at the beginning of the academic

session. He then calculated the correlation between the two sets of scores.

In this example, the independent variable is socio-economic status and the dependent variable is academic achievement. The correlation between the two sets of scores shows the status of relationship between socio-economic relationship and academic achievement at a particular time. The independent variable has not been manipulated in the present example. It is, therefore, non-experimental research study. It is correlational study because the relationship has been determined between the two variables at a particular time.

On the other hand if the research study was of such a nature that the researcher wanted to study the difference between the two variables it is called difference study. For example if the researcher wanted to know if male and female teachers differed on their relationship with the students. He selected 200 teachers of each sex and performed a statistical test of the difference between their teacher-student relationship. It was a difference study. In this study the independent variable was sex and the dependent variable teacher-student relationship. Since it was not possible to manipulate the independent variable in this study, it is also non-experimental research. Thus we can say that the non-experimental research study may be relationship study or difference study.

### 3. Experimental Research

Let us take an example in which the independent variable can be manipulated. Suppose an educational researcher wants to determine the relative effectiveness of two different methods of teaching children and their

reading ability. The researcher randomly selected two groups of children and taught one method through the lecture method and the other group through discussion method for 3 months. The reading ability of the two groups was tested through a standard reading test in the beginning as well as closing of the school year. In this example the methods of teaching are independent variable and reading ability was dependent variable. In this example the teacher has introduced two methods of teaching. By doing so the independent has been manipulated. It is, therefore called experimental research. The first test in this study was given in the beginning of the study and the second test was given at the end of the study. Thus this study was concerned with change scores.

#### 4. Conclusions

It can be safely concluded that the experimental research studies are generally concerned with change scores and non-experimental studies are generally concerned with status scores. But the basic difference is while independent variable is manipulated in experimental research studies, it is not manipulated in non-experimental research studies.

The research which is done to assess the changes for a long period is called longitudinal development study. In such studies "age" is independent variable which changes naturally and therefore is not manipulated by the researcher. In such study if the researcher assesses the effect of age at a particular age, it is status study. If it studies the relationship of dependent variable with some other variable, it is change score study. Thus it is

possible that in one study a researcher may deal with both status and change scores.

If the researcher made a survey of the opinions on educational issues for a number of successive years, the survey normally would not involve the manipulation of an independent variable. Such surveys which are conducted at periodical intervals are of the non-experimental type.

### QUESTIONS

- (1) *What do you mean by experimental research? Give examples.*
- (2) *What do you mean by non-experimental research? Give examples.*
- (3) *What do you mean by manipulation of variable in educational research? Discuss.*

## Experimental and Control Groups

---

Suppose an educational researcher wants to see the impact of two methods of teaching on academic achievement. He randomly selects 100 students. He then divides them into two groups by randomly assigning 50 to group A, the usual method of teaching and 50 to group B, a novel method of teaching designed to provide knowledge of the subject upto a certain level. At the end of the school terminal test, the researcher administered a test of academic achievement to each group. This is an experimental study. It is called experimental study because the independent variable is manipulated in it. If in this study a comparison was made between the boys and girls, it would not require manipulation of the independent variable.

In non-experimental hypothesis-testing research, experimental groups are not possible because

independent variable is not manipulated. The two groups are selected in a manner likely to yield representative samples of the population of students. The method of selecting the sample is most likely lead to comparable samples at the beginning of the study.

In the above example of two methods of teaching, the group which is taught through usual method of teaching is called control group and the group which is taught a novel method of teaching is called experimental group. It is called control group because it was taught through usual method. The other group is called experimental because an experiment is being made to teach through a novel method. If in any research study both the groups are taught through some novel method, both the groups will be called experimental groups. Thus the research design can be formulated which include only experimental groups or which include experimental and control groups. If two groups which are comparable are treated under different conditions, it provides a basis through which the researcher can determine the relative effectiveness of the independent variables. Randomization usually leads to formulation of comparable groups. The effects of extraneous variable is also controlled for both groups by eliminating the differential effects of the variables. But there is a difference in "control group" and "controlling" for extraneous variables. The "controlling" for extraneous variables eliminates their differential effects, comparisons between usual and novel method is made by including a control group in the research study. But one thing is common both in "control" group and "controlling" extraneous variables. It is adding definitiveness to a study.

Let us take a hypothesis for consideration.

“Children shown films on national integration will indicate a more positive attitude toward national integration than will children shown riot films”.

In this hypothesis both groups are experimental groups because both the groups are exposed to new conditions. It cannot be concluded at the end of the study in this hypothesis whether the attitudes of the two groups differed from the attitude of children who are not included in either group. The reason for not making such conclusion is the absence of the control group from the study. If a third group is added in the study which has not seen any of these two films such a group would be termed as a control group. Thus the researcher can compare the relative effectiveness of two experimental conditions without including a control group. However, he cannot determine whether either group would perform differently from a group exposed to usual conditions.

## QUESTIONS

- (1) *What is the need of making groups in educational research?*
- (2) *What do you mean by experimental group? Give examples from educational situation.*
- (3) *What do you mean by control group? Give examples from educational situation.*

## Simple Randomized Design

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### 1. Steps

The first step in obtaining samples in the two-group simple randomized design is to define the population. When the population has been designed, it is then necessary that the researcher should select randomly a sample. If the researcher randomly selects a sample it will result into selection that is representative of the population. The next step in this design is that individuals selected in the sample should be randomly assigned to the control group and experimental group.

### 2. Pre-testing and Post-testing

The control group is taught through the usual translation method and the experimental group is

through direct method. The researcher hypothesizes greater achievement for the direct method group. To find out which group learnt better in English language during the year, the researcher should test each group before the programme begins and after the programme ends. *The researcher should then compare the quantum* of achievement for the two groups for this one year period.

### 3. Two-Group Simple Randomized Design

In this study the method of teaching English is independent variable. The quantum of achievement in English is the dependent variable. The two groups were alike on the test of English language before the study was started. This assumption is reasonable because the two groups were made comparable through assigning the students randomly to the two groups. The random assignment of students to the two groups made them comparable on extraneous independent variables which are correlated with the dependent variable. The independent variable is manipulated in this study. Thus this study is of the experimental hypothesis--testing type. The design of this study is called as two-group simple randomized design because students are randomly selected and are not stratified on control variables. It is possible to generalize from these samples to the population. The two treatments in this study are "translation method" and "Direct method". The two treatments are administered to different groups. The two treatments are independently administered to the experimental and control groups in the sense that no one in the control group was taught through direct method. It is desirable to maximise differences between

treatment groups to test research hypothesis. The more alike are two treatment groups--the likely the researcher will obtain differences between the groups in the dependent variable. The researcher should expect that their achievement would be the same if two randomly *assigned groups are given identical treatment in every* respect. Thus it can be said that the simple randomized design requires that the individuals be randomly selected from a population and randomly assigned to different treatments of the independent variable.

#### 4. Procedure

In this study, the competence of the teacher can play great role in the outcome of this study. Suppose the teacher who teaches English through translation method is more competent than the teacher who teaches English through direct method while direct method is considered more effective than translation method. The true effect of the direct method would be reduced due to competence of the teacher who teaches through direct method.

If there was great difference in the competence of the two teachers it is possible that "translation method" might appear more effective than the "direct method". The effect of teacher differences in the two treatment groups can be minimized by having many teachers independently conducting treatment groups. The best situation is to assign students to the treatments randomly as well as teachers to the treatments randomly.

The researcher can design his study to minimise such differences which occur due to differences in the effectiveness of the teachers as pointed out in the

previous paragraph. It is done by random replications design which can reduce the effect of such differences by arranging a number of repetitions of each treatment. In research, each repetition is termed as a "replication".

In this design, two populations are taken one of individuals available for study and the other of individuals available to conduct treatments. Then a sample is selected from the populations of individuals available for study. This sample is randomly assigned to five experimental and five control groups. Then ten individuals are selected from the population of those available to conduct treatments. Then those ten individuals are randomly assigned to ten groups of population of individuals available for study. The random replications design serves two purposes. Firstly it controls for the differential effects of extraneous independent variables. Secondly it randomizes any individual differences among those conducting the treatments.

An educational researcher wants to compare the "Touch system" with the "sight system" in teaching of Type-writing for beginning students of Type-writing. He will have to set up 10 classes of 20 students in each class. The five classes were for "Touch system" and five for "sight system". It is called a random replications design. It will be as follows in the present study.

TABLE : Type-Writing Production

	Tough System	Sight System
Replication	1 E	1 C
	2 E	2 C
	3 E	3 C
	4 E	4 C
	5 E	5 C

The researcher will have to make random selection and random assignment of both students and methods. The researcher has set up five experimental and five control groups. The design is not concerned with any particular replication. The overall effectiveness of Touch System and Sight System is to be compared. The researcher has controlled for the effects of the extraneous in dependent variable by having the same number of children in each class. Therefore, the size of class is not likely to affect the results of this study. Variables relating to student and method of teaching type-writing characteristics are assumed to be randomly distributed among the two groups. The random replication design is an extension of the two group simple randomized design.

## QUESTIONS

- (1) *What do you mean by simple Randomized Design? Discuss.*
- (2) *What is the need of pre-testing and post-testing in educational research?*
- (3) *What are the necessary steps for obtaining two-group simple randomized design?*
- (4) *Write the procedure of educational research by obtaining simple randomized design.*

## Simple Factorial Design

---

### 1. Meaning

In the previous chapter, the effects of extraneous independent variables have been controlled through randomization. In that design, the individuals have been sampled disregarding the stratification of the sample on some extraneous variable. For this reason, the simple randomized design does not permit the researcher to find out the differential effect of the treatments at different levels of some extraneous variable. If the researcher wants to find out, as he should, the differential effects of treatment at various levels of an extraneous variable, he must control for this variable by homogeneity. It permits the researcher to find out the effects of the independent variable on the dependent variable at different levels of the extraneous variable.

Such research design is called a simple factorial design. It controls for an extraneous variable by homogeneity rather than by randomization.

## 2. $2 \times 2$ Simple Factorial Design

### *Simple Factorial Design*

TABLE 1 : Experimental Variable

Control Variable	Treatment X	Treatment Y
High level	Cell 1	Cell 3
Low level	Cell 2	Cell 4

The Table 1 is a graphic representation of a  $2 \times 2$  simple factorial design. The extraneous variable has been called control variable. It is to be controlled by homogeneity. The independent variable has been called experimental variable because it can be manipulated. In this design, there are two treatments and two levels. The treatments are of the experimental variable and the levels are of the control variable. The design has four cells which have been numbered 1, 2, 3, and 4. The cell No. 1 has those individuals who are receiving treatment X of the experimental variable and are at High level of the control variable. The cell No. 3 has those individuals who are receiving treatment Y of the experimental variable and are at High level of the control variable. It is called a treatment by level design because there are treatments of the experimental variable and levels of the control variable.

Now let us take research study in which

- (i) The researcher assesses the effectiveness of two treatments of training--treatments X and Y--on the ability of students.
- (ii) The researcher assumes that there is a differential effect of these treatments on the level of intelligence of the students.
- (iii) The researcher has stratified the population into Level I and Level II on Intelligence and randomly selected 50 students from each group.
- (iv) The researcher has then randomly assigned 25 students from Level I intelligence group to treatment X and 30 to treatment Y.
- (v) The researcher repeated the process of No. (iv) for the Level II group.
- (vi) The researcher has randomly assigned teachers to the groups.

TABLE 2 : Training

Intelligence Level	Treatment X	Treatment Y	
Level II	33	48	40.5
Level I	70	60	65
	51.5	54	

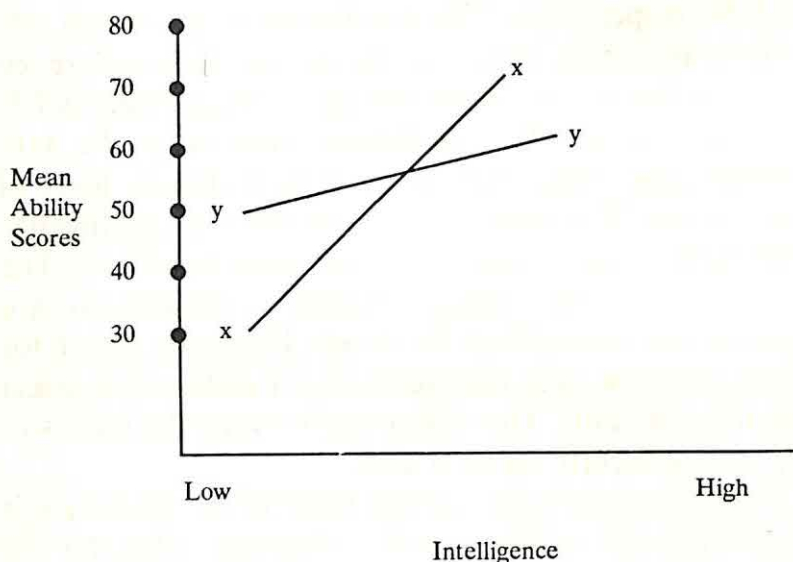
This sample factorial design includes two treatments of Training and two levels of intelligence. Intelligence is the control variable. The students' ability is the dependent variable. The scores in the four cells represent the mean scores for the dependent variable. The mean score for the treatment X, Level II intelligence group is 33. The mean scores for the four cells represent the combinations of treatments by levels. In addition to the four cell scores, there are four

marginal mean scores : two for rows and two for columns. The margin column means are for the two treatments and the marginal row means are for the two levels. The mean scores for treatment X and Y are 51.5 and 54 respectively. The treatment mean scores are termed the main effect for treatment. The difference between the means of the treatment main effect is 2.5. The main effect for treatments does not take into account any differential effect that is due to level of intelligence. The mean scores for the low intelligence level is 40.5 and for the high intelligence level is 65. The level mean scores without regard to treatments are termed the main effect for level. The main effect for levels does not take into account any differential effect due to treatments. The difference between the means of the main effect for levels is 24.5.

The difference between the main effect for levels is larger than the main effect for treatment. Thus far the simple factorial design has enabled the researcher to arrive at two independent estimates of the effectiveness of his study--one for the main effect treatments and one for the main effects of levels. The difference between the means for levels of intelligence is less for treatment Y than for treatment X. The influence of intelligence on ability is greater for treatment X. It cannot be concluded that treatment Y is more effective than treatment X regardless of intelligence level. The treatment Y appears to be more effective for the low intelligence group and treatment X appears to be more effective for the high intelligence group. Thus a particular combination of treatment and level of intelligence interact to produce greater gains than some other combination. An advantage of the simple factorial

design is that the researcher can examine the interaction between treatments and levels.

**Graphic Representation of Table 2**



The diagram illustrates the interaction effects between treatments and levels on the dependent variable of ability. It can also be said that there is an interaction between treatment and levels is that the treatment and levels are not independent of each other. In this research study it can be said that the effectiveness of a particular treatment is dependent upon the intelligence level.

The  $2 \times 2$  simple factorial design enabled the researcher within one study to determine the main effects of two treatments, the main effects of two levels of some control variable and the interaction effects of treatments and levels.

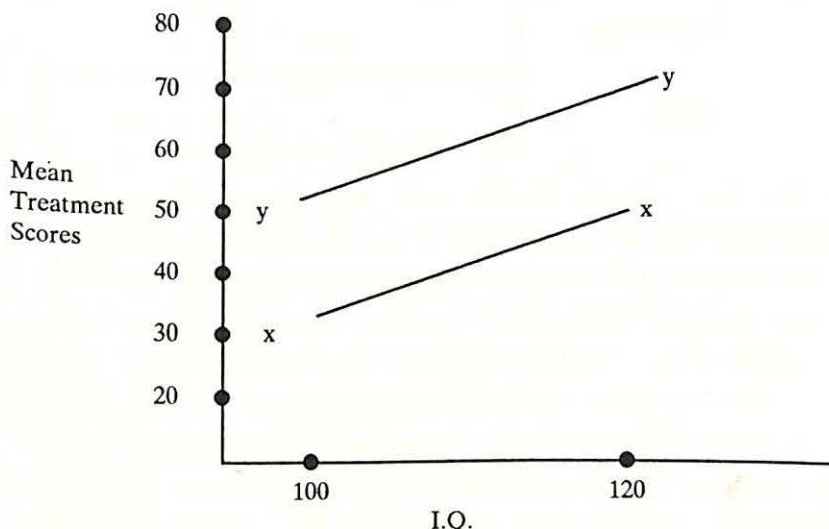
The following data was obtained by a researcher.

TABLE 3. Treatments

Intelligence Quotient	X	Y	
100	40	56	48
120	60	76	68
	50	66	

The difference between the means for the treatment main effects is 16 points. The difference between the means for the level main effects is 20 points. Treatment Y appears to be more effective than treatment X. Regardless of treatment, the high I.Q. group performs better than the low I.Q. group.

Graphic Representation of Table 3



There appears to be no differential effect of the treatments based on I.Q. level. Treatments and levels in this study are relatively independent of each other. Thus

it can be said that there is not an interaction effect between treatment and levels. The examples of simple factorial designs given in Graphic Representation of Tables 2 and 3 illustrated studies with one experimental variable and one control variable. The  $2 \times 2$  design need not be restricted in this manner but may include two experimental variables or two control variables.

An educational researcher compares the effects of class size as well as the use of text book on the learning of Mathematics. He conducts a survey using a  $2 \times 2$  simple factorial design.

Experimental Variable :      Experimental Variable X :  
Teaching Method                      Class Size

	Small	Usual
Text book		
Usual		

In this study both the variables have been manipulated. It illustrates a  $2 \times 2$  simple factorial design with no control variable but two experimental variables. Experimental variable X is class size and experimental variable Y is teaching method. The treatments of class size and teaching method both contain a "usual" group indicating that there are two control groups included in the study. There are two experimental variables no control variable, two experimental groups and two control groups in this study. The treatment main effects for columns deal with the experimental variable of class size. The treatment main effects for rows deal with the experimental variable of method of Teaching. This study

design permits not only the independent analysis of the main effects for both experimental variables but also an analysis of the inter-action between the treatments.

### 3. $4 \times 3$ Simple Factorial Design

#### *Simple Factorial Design*

TABLE 4 : Experimental Variable

Control Variable	Treatment W	Treatment X	Treatment Y	Treatment Z
Level I	Cell 1	Cell 4	Cell 7	Cell 10
Level II	Cell 2	Cell 5	Cell 8	Cell 11
Level III	Cell 3	Cell 6	Cell 9	Cell 12

There are four treatments of experimental variables and three levels of the control variable in this simple factorial design. It is  $4 \times 3$  simple factorial design. The simple factorial can be generalized to any number of treatments and any number of levels. In the Table 4, there are 12 cells. The individuals in cell 1 are receiving treatment W and are at level I. The individuals in cell 12 are receiving treatment Z and are at Level III. The individuals receiving treatment W and at level III are in cell 3. The individuals receiving treatment Y and at level II are in cell 8. If the researcher makes a comparison of the means for the columns he gets an estimate of the main effects for the treatments. If the researcher makes a comparison of the means for the rows he gets an estimate of the main effects for the levels. Thus the column main effects are for the experimental variable and the row main effects are for the control variable.

There is an additional advantage in simple factorial design because it not only provides row and column main effects but it helps the researcher to determine the interaction between treatments and levels.

### QUESTIONS

- (1) *What do you mean by simple factorial design?*
- (2) *Discuss the procedure of educational research in  $2 \times 2$  simple factorial design.*
- (3) *Discuss the procedure of educational research in  $4 \times 3$  simple factorial design.*

## Complex Factorial Design

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### 1. Meaning

You have read in the previous chapter that if there are two independent variables the researcher obtains not only main effects of the two variables but also the interaction between these two variables. But the interaction in the simple factorial design is called a "First Order Interaction" because there are only two independent variables. If the researcher wants to determine "Second Order Interaction", he must include in his design three independent variables. Any design which has atleast three independent variables it is called complex factorial design.

## Complex Factorial Design

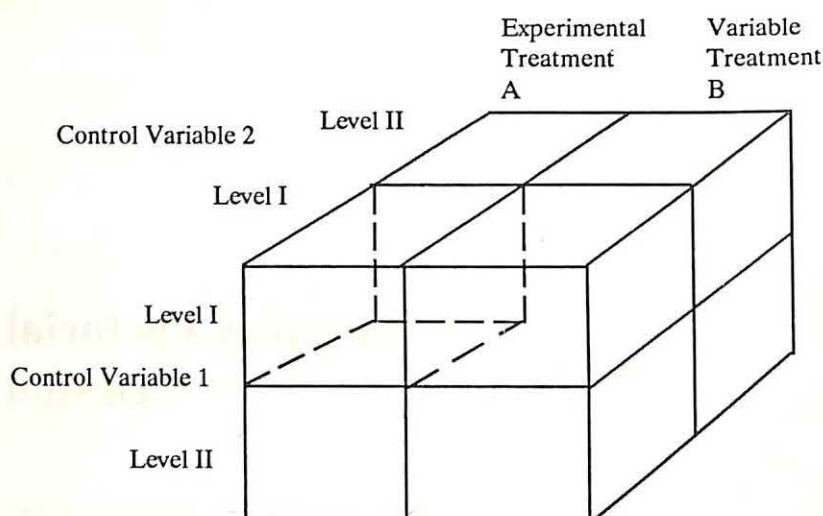


Fig. 1

## 2. Procedure

There is one experimental variable and two control variables in the design given above Fig. 1. There are two treatments of experimental variable and there are two levels of each control variable. It is called  $2 \times 2 \times 2$  design. It is a complex factorial design of  $2 \times 2 \times 2$ . It contains eight cells. The outlined cell is for treatment A level I of control variable 1 and level I of control variable 2. This outline shows that the researcher can determine the main effects for three independent variables. There are three main effects for-experimental variable, control variables 1 and 2. They are (i) Experimental variable with control variable 1, (ii) Experimental variable with control variable 2, and (iii) Control variable 1 with control variable 2. Since there are three independent

variable in Fig. 1, so it is an example of a complex factorial design, and it is of second order interaction. It permits the analysis of one second order interaction.

Thus we can say that main effects deal with the effects of one independent variable only. It may be the effect of experimental variable or control variable 1 or control variable 2. It cannot deal more than one independent variable at a time.

It may also be concluded that first order interactions deal with the effects of :

- (i) Experimental variable with control variable 1.
- or (ii) Experimental variable with control variable 2.
- or (iii) Control variable 1 with control variable 2.

Thus there are the effects of only two independent variables in First order of interactions.

It may also be concluded that second order interactions deal with the effects of Experimental Variable, control variable 1 and control variable.

2. Thus there are the effects of only three independent variables in second order of interaction.

In Fig. 1, there are 8 cells. They can be tabulated as follows :

TABLE 1 : Experimental Variable

Treatment X		Treatment Y	
Control Variable 2		Control Variable 2	
Level 1	Level 2	Level 1	Level 2
Cell 1	Cell 3	Cell 5	Cell 7
Cell 2	Cell 4	Cell 6	Cell 8

Control Variable 1    Level  
I                      II

In Table 1 there are four cells within treatment X and four cells within treatment Y. The analysis of the data for treatments X and Y provides a test of the main effects for the experimental variable. The researcher should compare the combined data in cells 1, 2, 3 and 4 with the combined data in cells 5, 6, 7 and 8 for finding out the main effect for the experimental variable. The researcher gets the main effect for the experimental variable when he combines within each treatment regardless of control variable 1 and control variable 2.

There are two levels of control variable 1. If the researcher wants to determine the main effect for the control variable 1 it is necessary that he should combine the data for the cells included in level I and compare it with the combined data for the cells included in level II. Thus, if the researcher wants to determine the main effect for control variable 1, it is necessary that he should combine the data in cells, 1, 3, 5 and 7 and compare it with the combined data for the cells 2, 4, 6 and 8. If the researcher combines the cells in this manner, he analyses the main effect of control variable 1 independent of the effects of the experimental variable and control variable 2.

Similarly, there are two levels of control variable 2. If the researcher wants to determine the main effect for this variable, he should compare the data for the cells included in level I with the data for cells included in level II for this variable. Thus the researcher should compare the combined data in cells 1, 2, 5, and 6 with the combined data in cells 3, 4, 7 and 8 for determining the main effect for control variable 2.

You have already read earlier

- (i) The control variable 2 should be ignored if the researcher wants to obtain the first order interaction of experimental variable (EV)  $\times$  control variable 1 (CV1).
- (ii) The control variable 1 should be ignored if the researcher wants to obtain the first order interaction of experimental variable (EV)  $\times$  control variable 2 (CV2).
- (iii) The experimental variable should be ignored if the researcher wants to obtain the first order interaction for control variable 1 (CV1)  $\times$  Control variable 2 (CV2).

Let us take them one by one.

- (i) If the researcher ignores control variable 2, the analysis deals, with the interaction effects of two independent variables. It becomes a simple factorial design because he deals only with a first order interaction when he ignores control variable 2. It can be shown as follows.

Treatment Variable 1	Experimental variable	
	Treatment X	Treatment Y
Level I	Cells 1, 3	Cells 5, 7
Level II	Cells 2, 4	Cells 6, 8

- (ii) If the researcher ignores control variable 1, the analysis deals with the interaction effects of two independent variables. It becomes a simple factorial design he deals only with a first order

interaction when he ignores control variable 1. It can be shown as follows :

Treatment Variable 2	Experimental Variable	
	Treatment X	Treatment Y
Level I	Cells 1, 2	Cells 5, 6
Level II	Cells 3, 4	Cells 7, 8

- (iii) If the researcher ignores experimental variable, the analysis deals with the interaction effects of two independent variables. It becomes a simple factorial design because he deals only with a first order interaction when he ignores experimental variable. It can be shown as follows :

Control Variable 1	Control Variable 2	
	Level I	Level II
Level I	Cells 1, 5	Cells 3, 7
Level II	Cells 2, 6	Cells 4, 8

If the researcher wants to make the analysis of the second order interaction, he cannot ignore one of the independent variables. If the experimental and two control variables are analysed at the same time, the researcher will get a second order interaction.

Thus it can be concluded that any research design which permits the researcher to take into account three or more independent variables at the same time it is called complex factorial design. No doubt,  $2 \times 2 \times 2$  design is a complex factorial design but it cannot be

restricted to  $2 \times 2 \times 2$  design only. It can be generalized to any number and combination of experimental variable and control independent variables. If the researcher increases the number of independent variables the factorial design becomes more and more complex. The simple principle is the greater the number of independent variables the higher the order of interaction analysis possible.

### QUESTIONS

- (1) *What do you mean by complex factorial design?*
- (2) *What do you mean by first order interaction? Give examples.*
- (3) *What do you mean by first order interaction ? Give examples.*
- (4) *Discuss the procedure of educational research thought complex factorial design.*

## Introduction to Research Methods

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It is a difficult task to classify educational research into methods because there is too much overlapping in their purposes and procedures. Thus there is no natural system of categorizing research methods which may put the different methods neatly in clear-cut compartments.

Barr points out that research methods can be categorized on the basis of

- (i) goal or and result
- (ii) data gathering techniques
- (iii) data processing methods
- (iv) degree of control
- (v) approach
- (vi) source of the data

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Educational research can also be classified as

- (i) Basic research of Fundamental research
- (ii) Applied research
- (iii) Action research

Educational research can also be classified area wise as follows :

- (i) Research in Philosophy of Education
- (ii) Research in History
- (iii) Research in Sociology of Education
- (iv) Research in Comparative Education
- (v) Research in Economics of Education
- (vi) Research in Learning theories
- (vii) Research in Motivational devices
- (viii) Research in Personality traits
- (ix) Research in Guidance and Counselling
- (x) Research in Tests and Measurement
- (xi) Research in Curriculum Development
- (xii) Research in Methods of Teaching
- (xiii) Research in Text book Content
- (xiv) Research in Language Teaching
- (xv) Research in Educational Technology
- (xvi) Research in Correlates of Achievement
- (xvii) Research in Teaching and Teacher Behaviour
- (xviii) Research in Teacher Education
- (xix) Research in Educational Management and Administration
- (xx) Research in Non-formal Education

But in practice, most authors have divided research methods into three categories. Mouly has divided research method in the book "The Science of Educational Research" in the following categories :

## 1. Historical Method

It is concerned with the past and in it attempts are made to find out the past in the perspective of the present. Its process involves investigating, recording, analysing and interpreting the events of the past for discovering generalisation. The historical method can be studied under the following headings :

- (i) Historical
- (ii) Logical
- (iii) Documentary

## 2. Survey Method

It is concerned with the present and in it attempts are made to find out the present position of the phenomena which is being investigated. Its process involves description, recording, analysing and interpreting conditions that now exist. It often involves some types of comparison or contrasts and may attempt to discover cause and effect relationship. The survey methods can be studied under the following headings :

- (i) descriptive
  - (a) survey testing
  - (b) questionnaire
  - (c) interview

- (ii) analytical
  - (a) documentary frequency
  - (b) observational
  - (c) rating
  - (d) critical incident
  - (e) factor analysis
- (iii) school surveys
- (iv) genetic surveys

### 3. Experimental Method

It is oriented towards what will be when certain variables are carefully controlled or manipulated. Attempts are made to find out cause effect relationship.

The experimental method may be studied under the following headings :

- (i) Simple experimental design
- (ii) Multi variable analysis
- (iii) Case study
- (iv) Predictives

The classification of methods into various categories is not precised and it is questionable that why a particular kind of research has been assigned to a particular method of research. But the particular allocation of the various methods to a category is a matter of judgement.

But categorisation is necessary also because if the **researcher** does not know the approach which he is using **research**, his understanding will be vague and his approach will be ineffective.

## QUESTIONS

- (1) *What are the bases of classifications of research methods? Discuss.*
- (2) *What is area wise classification of educational research? Discuss.*
- (3) *What are three main types of educational research? Discuss.*

## Historical Method

---

### 1. Meaning

Historical method is concerned with the past and attempts to trace the past as a means of seeing the present in perspective. It answers the questions what was.

### 2. Positive arguments

- (i) The problem is delimited. The hypotheses are formulated. Data are gathered and analysed. The hypotheses are tested but not empirically generalisation is done. Thus the method follows the proper procedure of research.
- (ii) The evidence which is collected is rigorously

subjected to critical analysis. It does not permit wrong generalisation.

- (iii) When there are gaps in evidence contribution to proper conclusion, the researcher makes the use of principle of probability.
- (iv) The variables in educational research cannot be controlled in historical method but that is true about all social sciences research.

### 3. Negative arguments

- (i) One of the main purposes of the research is prediction of the findings but it cannot be achieved in all the cases through historical method.
- (ii) The accounts given by those persons who have not witnessed the event is also accepted as an evidence.
- (iii) There is no guarantee that the eye witness has witnessed the event objectively. If his witness is subjective, its accuracy becomes doubtful which may result into wrong generalisation.
- (iv) Even the authenticity of the documents can be questioned.
- (v) Controlling conditions is not possible in this method.
- (vi) Filling in missing parts of the history through probability is not scientific method.

### 4. Primary Sources

It is data provided by actual witnesses to the incident in question. Primary sources include

- 
- (i) Documents kept and written by actual participants--autobiographies, letters, diaries, pictures, paintings, etc.
  - (ii) Remains or relics of an educationists, a group of educationists, periods, skeletons, tools, weapons, food utensils, clothing, building, furniture, library
  - (iii) Oral testimony of witnesses such as Principals, teachers, students, employees and parents.

## 5. Secondary Sources

They are sources in which a middle man comes between the original witness and the present researcher. They include

- (i) History text
- (ii) Educational encyclopaedia
- (iii) Matter written by others in the past on the problem.

## 6. Historical Criticism

It is necessary that data should be subjected to careful analysis. It should sift the true from the false. Irrelevant or misleading facts should be eliminated. No subjectively should be allowed for this.

It may be of two types :

- (i) *External criticism* : If the source itself is not considered genuine. Its authenticity or claim is doubted.
- (ii) *Internal criticism* : If what is given in the document is not accepted because the reporter may be biased or he might be wrong in his conclusion. Thus

internal criticism may be the result of intentional or unintentional statement of account.

## 7. Process in the Research Method

The following are the steps which are involved in the process of historical research.

- (i) To determine that the problem is suitable for the use of historical method.
- (ii) To specify the population required for the research
- (iii) To determine initially that the sufficient data are available
- (iv) To begin collection of data through
  - (a) consideration of data which are already known
  - (b) seeking new data from the primary and secondary sources
  - (c) seeking new and previous unknown data in the form of data and sources
- (v) To begin writing the report
- (vi) To interact the writing and continuing additional research for data or testing of data
- (vii) To complete the descriptive phase of research
- (viii) To complete the interpretive phase of research
- (ix) To apply data to present and hypotheses for future.

## QUESTIONS

- (1) *What do you mean by historical method? Discuss.*

- 
- (2) *What are the positive arguments for historical method?*
  - (3) *What are the negative arguments for historical method?*
  - (4) *Give the examples of primary sources and secondary sources in educational research.*
  - (5) *What do you mean by historical criticism? Differentiate between external criticism and internal criticism.*
  - (6) *Write the steps involved in historical method.*

## **Descriptive Survey Method**

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### **1. Descriptive Method**

Descriptive method is also known as the survey method. It is concerned with the present and attempts to determine the status of the phenomenon under investigation.

### **2. Nature**

The nature of the descriptive method is as follows :

- (i) It deals with the present
- (ii) It is oriented towards the determination of the status of a given phenomenon rather than isolating causing factors accounting for its existence

- (iii) It is generally based on cross-sectional samples
- (iv) It has a fact-finding approach
- (v) It studies significant relationship among phenomena.

### 3. Purposes

The following purposes are served by descriptive method :

- (i) It provides necessary information which helps the administrator for making decisions
- (ii) It provides necessary information and plan for improvement so it is forward-looking.
- (iii) It interprets, synthesizes and integrates data and points out their implications.
- (iv) It is more realistic because investigation is done in this method in natural setting.
- (v) It is the only method through which the researcher can obtain the opinions, attitudes and suggestions for improvement.
- (vi) It is useful in the development of research tools such as checklists, questionnaires, opinionnaires etc.

### 4. Types

Descriptive method is divided into four parts. They are

- (i) Survey studies
- (ii) Inter-relationship studies
- (iii) Developmental studies
- (iv) Content analysis

4. (i) The survey studies are of the following types :
- (a) School surveys
  - (b) Job analysis
  - (c) Documentary analysis
  - (d) Public opinion surveys
  - (e) Social surveys
4. (ii) The Inter-relationship studies are of the following types :
- (a) Case study
  - (b) Causal-comparative studies
  - (c) Correlation studies
  - (d) Prediction studies
  - (e) Cross-cultural studies
  - (f) Comparative studies.
4. (iii) The developmental studies are of the following types :
- (a) Growth studies-Longitudinal and Cross-sectional
  - (b) Follow up studies
  - (c) Trend studies
4. (iv) The content analysis deals with the nature utility and procedure of content analysis

Let us take them one by one :

4. (i) (a) The school surveys are done relating to aims and objectives of a particular school, outcomes of the school performance, students' achievements in various

subjects, methods and techniques of teaching practised in different subjects in different schools and teaching and instructional aids used or available in the schools. The administrative problems of the schools are also found out through surveys. The existing financial policies and procedure are also surveyed. The information relating to staff and students and facilities provided by the schools are also investigated. The existing facilities available in the school plant and the comparative studies of different schools plants are also found out. The school surveys may be related to achievement, intelligence and personality testing of students.

4. (i) (b) The job analysis research is also done through survey studies. In such survey studies information about the duties of all the staff members and matching it with the staff qualifications. The data about the education, specialized training, experience, skills, habits, health standards and behavioural traits of teaching and non-teaching staff are collected.

Van Daten has pointed out that job analyses help administrators and educationists to :

- (a) detect weaknesses, duplications or inefficiency in the present work procedures;
- (b) establish uniform classifications of similar work;
- (c) determine wage or salary schedules for jobs entailing various levels or skills or responsibility;
- (d) identify the competencies to seek when employing personnel;
- (e) assign workers to jobs in a manner that will achieve the best utilisation of the available manpower;

- (f) set up training programmes and prepare instructional materials for prospective or inservice employees;
- (g) establish requirements for promotion;
- (h) make decisions concerning the transfer or retraining of personnel; and
- (i) develop theoretical frame work for studying administrative functions and structures.

4. (i) (c) The documentary analysis is that part of descriptive research which is very close to historical research with this difference that while descriptive research is concerned with the immediate past and the present, the historical research is related to distant past.

Documentary analysis is also called as content analysis, activity analysis or informational analysis. The documents whose analysis is to be made may be written, printed, verbal or pictorial. It may include

- (a) studying existing record in the form of census, birth, accident, crime, school, institutional and personal records
- (b) analysing text books, syllabi, courses of study, lesson plans and prospectus etc.
- (c) analysing contents of reference work, newspapers, periodicals and journals
- (d) studying personal documents, such as diaries, letters and notes
- (e) examining administrative records, forms and reports and cumulative records of students.

4. (i) (d) Public opinion surveys are used in educational research for finding out the opinions of

various segments of society on different educational issues and problems. The opinions may be collected through questionnaires, schedules, interviews or seminars. The document "Challenge of Education" was issued by the Govt. of India to collect opinion relating to various educational issues. Press also plays an important role in organizing public opinion surveys on different issues.

4. (i) (e) Social surveys are used for studying health services, employment conditions, having problems, transport difficulties and shortage of hostels etc. Questionnaires, schedules, interviews, rating scales and direct observations are used as tools of research. They are also called community surveys. The information about the community in neighbouring schools or of community schools is also collected through social surveys.

Such surveys can be taken by individuals, voluntary organization, local bodies and state or central governments.

4. (ii) *Inter-relationship studies* : Some educational researcher do not restrict their research studies to accurate description of the present position, they try to find out the relationship between different variables of the existing situation.

Let us discuss the different types of inter-relationship studies one by one.

4. (ii) (a) Case study is an intensive investigation of an individual, a family, an institution, a group or a gang. The following are the steps of case study :

- (i) to determine the present status of a social unit
- (ii) to determine the most probable antecedents of case

- (iii) to formulate hypotheses
- (iv) to verify hypotheses
- (v) to direct towards further validation of the diagnoses
- (vi) to suggest remedial measures
- (vii) to follow up the case

4. (ii) (b) Causal-comparative studies go one more step in the research studies. The researchers do not restrict them to find out the relationship between different variables but they try to find out how and why it happens so. The researcher tries to find out what factors or circumstances are responsible for the happenings of certain events, conditions or practices. He tries to compare the likeness and differences among different factors.

These studies are done by using Mill's Method of Agreement which states :

“If two or more instances of the phenomenon under investigation have only one circumstances in common, the circumstances in which alone all the instances agree is the cause (or effect) of the given phenomena”.

These studies are used when the nature of the research problem is such that the researcher cannot manipulate the independent variable and establish the controls that are required in experiments. For example no researcher can manipulate the variables like home background, socio-economic status and intelligence of children to study their effect on emotional stability of the children. These studies are sometimes as a substitute of experimental method to save time, money and effort.

However, causal-comparative studies suffer from the following limitations :

- (i) Lack of control
- (ii) difficult to identify the relevant factor
- (iii) Complexity of different factors
- (iv) difficult to determine which is cause and which is effect in some cases
- (v) problem of classification of subjects
- (vi) difficult to identify existing group of subjects who are identical in all respects except one.

But these studies are very useful for investigating those problems which cannot be probed in laboratory situations.

4. (ii) (c) Correlation studies are used where the researcher proposes to determine the extent of relationship between different variables. Such studies can be easily designed and conducted. The researcher has to set up two sets of measurements of the subjects in which he wants to see the relationship. The Ranking Method or the Product-moment Method can be used for calculating the relationship. It can vary from  $+1$  to  $-1$ . If there is a perfect positive correlation, it is indicated as  $+1$ . If there is a perfect negative correlation, it is indicated as  $-1$ . But both these are extreme positions which hardly exist in real situation. But if in one study the correlation is calculated as  $.75$  and in the other it is calculated as  $.35$ , we can safely say that there is more relationship in the variables in the first study than in the second study.

4. (ii) (d) Prediction studies are used where one variable can predict another variable. This prediction may show the positive relationship or negative

relationship between two variables : For example if the researcher predicts positive relationship between intelligence and academic achievement, high score on the former means high score the latter and poor score on the former means poor score on the latter.

Guilford has mentioned four types of production.

- (a) one attribute is predicted from another attribute : For example predicting morality incidence from family background.
- (b) attribute is predicted from measurement : For example predicting morality incidence from I.Q.
- (c) measurement is predicted from an attributed : For example predicting academic achievement from socio-economic status
- (d) measurement is predicted from another measurement : For example predicting academic achievement from I.Q.

4. (ii) (e) The cross culture studies are used for finding the comparison of a number of societies. Psychologists and anthropologists attempt to seek relationship between different races, cultures, societies and countries. For example studies in respect of relationship between the content of short stories of Prem Chand and Muslim culture, content of Urdu primary text books written by Ismail Meeruthi and moral teaching are good examples of cross culture studies.

However, there are difficulties in such type of studies because people are not ready to provide correct data about those things which are considered objectionable in particular culture. For example while it is easy to

make studies relating to impact of dating on students' studies, it is not possible to do so in India on account of non-availability of reliable and comparable data. The requirement of knowledge of foreign languages may also create problems for the researcher. The selection of sample in such research studies may also be a great problem.

4. (ii) (f) The comparative studies are used for making researches relating to curriculum at different levels in different countries, methods of teaching practised in different countries, evaluation system prevalent in different countries and concept of students' descriptive in different societies.

But such studies are very time consuming and require lot of time, money and effort.

4. (iii) *Developmental studies* : These research studies are done when the researcher is interested in studying any aspect of life of the children at different age levels. For example the researcher may be interested in studying physical, social, moral and intellectual development of children during infancy, early childhood, later childhood and adolescence. Such studies will come under developmental studies.

Let us take different types of developmental studies one by one.

4. (iii) (a) *Growth studies* : These studies are used to find out the nature and rate of changes--Physical, emotional, moral and social etc. in children. Such studies may be longitudinal studies or cross-sectional. In longitudinal studies the researcher studies the same subject--a group of students, school, a college or a university over a relatively longer period time. They are generally used in clinics and laboratories. Terman and his Co-workers (1925, 1947, 1959), Gessel's motor and

Physical growth (1928, 1940 1946) and study of Honzik, Macfarland and Allen (1949) are good examples of classical growth studies.

In cross sectional growth studies, the researcher does not follow the same child, same children for the purpose of studies. He randomly selects samples of individuals of successive ages and one set of measurements of different individuals from each level.

4. (iii) (b) *The follow-up studies* : The follow-up studies are used when the researcher wants to continue his work even after findings. They are generally used in case study where the researcher tries to find out whether the treatment is successful or not. The nature of follow-up studies is longitudinal.

The studies done by Terman and his associates in 1947 were the follow-up studies of 1922, 1936, 1940 and 1945.

4. (iii) (c) *Trend studies* : These studies are used when the researcher is interested in identifying the trends on certain educational issues and predicting the future course of action. They are undertaken through documentary analysis or surveys at repeated intervals.

For example the following research problem may be done as trend studies.

- (a) Need for change in the syllabus of the course
- (b) Text book writing
- (c) Studies relating to students activities.

4. (iv) *Content Analysis* : It is an important type of descriptive research. The researcher tries to make the analysis of the content orally or in written form. Such studies may be done in the areas of curriculum, evaluation, comprehension level of students etc.

The important problems in this area are as follows :

- (a) Developing and modifying school curriculum
- (b) Developing a standardized test in any school subject
- (c) Differentiating aspects of different writing styles.

The following procedure is used in content analysis :

- (a) The unit of analysis should be defined
- (b) The frequency of particular words/phrases is determined
- (c) The researcher should consider the favourableness or unfavourableness of a single unit
- (d) The unit should be further classified according to direction and intensity
- (e) The researcher should not be over zealous in making the selection of the unit
- (f) A form is used in content analyses so that the units could be classified and record.

## 5. Process of the Research Method

The following are the steps which are involved in survey research method :

- (1) The research problem should be stated
- (2) It should be determined that the problem is appropriate for using survey research method
- (3) There are various types of survey. The researcher should select the appropriate type for the problem.

- (4) The objectives of the survey should be identified and they should be translated into criterion variables.
- (5) It should be determined that for which of the variables which have been identified in the problem.
  - (a) adequate techniques are available through which data can be collected
  - (b) adequate techniques can be developed by or through the researcher within the prescribed time of research.
  - (c) adequate techniques are not available and it is not possible for the researcher to develop or get them developed in the prescribed time.
- (6) It should be determined initially whether there are chances of success of the survey.
- (7) The population of research situation should be identified.
- (8) Initial determination of the availability of a representative sample should be made.
- (9) Decisions as to those aspects of survey for which representative sample can be obtained.
- (10) Final evaluation should be made about the success potential of survey in view of availability of adequate data-collection instruments and required sample and all potential results.
- (11) The data collection design should be prepared.
- (12) The data should be collected.
- (13) The data should be analysed.
- (14) The report should be prepared which should

have descriptive past, comparative or evaluative past and findings.

## QUESTIONS

- (1) *What do you mean by descriptive method of educational research? Discuss.*
- (2) *Discuss the nature of educational research.*
- (3) *What are the main purposes of descriptive method of educational research? Discuss.*
- (4) *What do you mean by survey studies? What types of researches can be taken under survey studies?*
- (5) *What do you mean by inter-relationship studies? What are the different forms in which inter-relationship studies can be taken?*
- (6) *What do you mean by developmental studies? Discuss.*
- (7) *Discuss growth studies and follow up studies in educational research. Give suitable examples.*
- (8) *Discuss the process of descriptive research method?*

## Experimental Method

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### 1. Definition

It may be defined as the study of the relationships among variables--those manipulated and those measured. It simply enables the researcher to improve the conditions under which the researcher observes and thus to arrive at a more precise results. It enables him to relate a given consequent to a specific antecedents rather than to a vague conglomeration of antecedents.

### 2. Elements

(1) *Control* : The extent to which different factors are accounted for :

(a) *Purposes of control* :

- (i) Intervening variables are isolated so that they may effect the dependent variables.
- (ii) Not only intervening variables are to be isolated from independent variables but it is also to be ascertained how much it contributed.
- (iii) The magnitude is not only ascertained in terms of larger or small but also in quantitative terms.

(b) *Degree of Control* : It has to be remembered that in educational research high degree of control is not possible as in laboratory situation.

(c) *Methods of Control* : The researcher directs efforts towards controlling the variables which are related to the independent variable otherwise it will be difficult to ascertain which is responsible for effect on dependent variable. The following methods are used for controlling.

- (i) Random assignment of subjects to groups :

It means that subjects are assigned in such a way that every member has an equal opportunity of being chosen.

- (ii) Matching subjects with random assignment :

The subjects are assigned to groups to match individuals subjects on as many extraneous variables as the researcher can identify. They may be

- (a) Subject to subject matching
  - (b) matching for mean and standard deviation
  - (c) Ranking of subjects on matching variable
- (iii) Random assignment on the basis of homogenous selection : It is done to make groups comparable

on an extraneous variable so as to select groups those are as homogenous as possible on the variable. The variable may be like socio-economic status and sex etc.

(iv) Techniques of analysis of Co-variance :

It is attempted to control the variations within the groups. A Co-variate is a variable which the researcher has not been able to control.

(v) Method of using subjects as their own controls :

It is done to assign the same subjects to two experimental treatments and then to obtain measurements of the subjects under one treatment and then on the other. But there is practical difficulty in this method in some cases.

(2) *Manipulation* : In the experimental method manipulation is done to set the stage for the occurrence of the factor whose performance is to be studied under conditions in which all other factors are controlled. Variables which can be manipulated may be method of teaching, attitudes, socio-economic status, classroom environment, personality characteristics and types of motivation.

(3) *Observation* : Another element of the experimental method is that the effect of the manipulation of independent variable on the dependent variable is studied or observed. The technique of observation is to be applied if measurement is not possible.

(4) *Replication* : In spite of attempts of controlling extraneous variables, some extraneous variable and some discrepancies remain and influence the results. Thus replication is a matter of conducting a number of

sub-experiments within the frame work of an overall experimental design.

### 3. Features

- (i) It is based on law of the single variable. It means if one element is added or subtracted in one of the two situations and the other situation is kept as it is, the change in the two situations is the result of that single variable.
- (ii) It is applicable when significant factor or conditions can be controlled.
- (iii) It is not a perfectly precise method in educational research as in scientific method.
- (iv) Control group and experimental group are never identical as they should be for an exact experiment.

### 4. Experimental Validity

Two types of validity are involved

(1) *Internal Validity* : It is the minimum without which an experiment is useless. The crucial point is whether the independent variable created the effect on the dependent variable. It means that some uncontrolled extraneous factors do not affect the dependent variable. The following eight extraneous factors are to be controlled for obtaining internal validity.

- (a) contemporary confounding factor
- (b) maturation of the subject with the passage of time

- (c) Experience in pre-test reflecting itself in the post-test
- (d) Changes in the calibration of the measuring instrument
- (e) Tendency for extreme scores to regress towards the mean
- (f) Differences in the selection of subjects in the pre-test and post-test
- (g) Differential loss of subjects from the experimental and control groups tend to bias the results of the experiment
- (h) Interaction of selection and maturation and selection and history

(2) *External Validity* : The crucial point is what is the applicability of the findings beyond the limits of particular experiment. Are the results valid in general for men, children etc.? The following factors are to be controlled for obtaining external validity :

- (a) Selection of sample with some special characteristics make the application restrictive.
- (b) Pre-testing may sensitize the subject to the experimental factor.
- (c) Effects of experimental procedures restrict the generalize ability of the findings.
- (d) Effects of a treatment on a subject previously exposed to other treatments cannot be generalized to other subjects who have not undergone the same sequence of treatments.

## 5. Experimental Design

It is to the researcher what a blue-print is to an architect. The following are the factors upon which the selection of design depends :

- (i) What is the nature of the experiment ?
- (ii) What is the main purpose of the experiment ?
- (iii) What types of the variables are to be manipulated ?
- (iv) What is the nature of data ?
- (v) What is the competence level of the experimenter ?

The experimental designs are classified as follows :

(A) *Pre-experimental designs* : In this type of design there is no control over extraneous or situation variables. They are divided into the following categories.

**DESIGN NO. 1 : One group, Pre-test--Post-test design**

Pre-test	Independent Variable	Post-test
$T_1$	X	$T_2$
Mean of the Criterion Test	Teaching through a particular method	Mean of the Criterion Test

Since there is no control group in this research design it cannot be checked whether the obtained result is due to treatment or extraneous variable. History and maturation are two major extraneous variables. The subjects are likely to give better performance at the post-stage even without teaching.

**DESIGN NO. 2 : Two group, Static Design**

Group	Independent Variable	Post-test
Experimental	Teaching through new method	$T_2$
Control	Teaching through conventional method	$T_2$

In this design, the two groups are assigned but neither on the basis of randomization nor matching. There is no pre-test so the researcher cannot measure the difference on account of treatment. In this design, comparison is made, on the basis of post-test, in experimental group and control group but it is possible this may not be due to difference of method of teaching in the two groups but on account of selection of samples and experimental mortality.

(B) *True-experimental designs* : In these designs, the researcher attempts to control the effects of history, maturation, testing, measuring instruments and mortality.

**DESIGN NO. 3 : Two groups, Randomized Subject, Post-test only Design**

Randomly assigned group	Independent Variable X	Post-Test
Experimental	Teaching through new method	$T_2$
Control	Teaching through conventional method	$T_2$

In this design, there is provision of randomization of subjects to the two groups, it assures the equivalence of groups and since there is no provision of pre-test there is probability of interaction effect.

However, the use of the design restricts the external validity of the experiment. There are some situations which do not permit selection of subjects at random.

**DESIGN NO. 4 : Two groups, Randomized Matched subjects, Post-test only Design.**

Randomly assigned groups after matching	Independent Variable	Post-test
Experimental	Instruction with interim test	$T_2$
Control	Instruction without interim test	$T_2$

This design is the most useful where small groups are to be used. In this design the subjects are randomly assigned to two groups after matching, it ensures strengths to design.

But it is very difficult to match the subjects with precision because it reduces the sizes of the sample. In some cases it is not possible to match one or more potential subjects. If some subjects are to be reduced for this purpose, a bias is introduced in the sample.

**DESIGN NO. 5 : Randomized groups--Pre-test, Post-test Design**

Randomly Assigned	Pre-test	Independent Variable	Post-test
Experimental group	$T_1 E$	Teaching through Structural approach	$T_2 E$
Control group	$T_1 C$	Teaching through traditional method	$T_2 C$

$$DE = T_2 E - T_1 E$$

$$DC = T_2 C - T_1 C$$

Compare DE and DC

In this design additional check is provided for the equality of Experimental group and Control group

because there is provision of pre-test. The nature of the design is such that it controls most of the extraneous variables.

However, the design has certain limitations. Firstly interaction between pre-test and treatment may sensitize subjects which may affect the results. Secondly interaction of experimental variable with other factor limits its generalisation. Thirdly experimental procedure may affect normalcy.

#### DESIGN NO. 6 : The Randomized Solomon Three-group Design

Randomly Assigned	Pre-test	Independent Variable	Post-test
Experimental Group (E)	$T_1 E$	Teaching through structural approach	$T_2 E$
Control Group 1 ( $C_1$ )	$T_1 C_1$	Teaching through conventional method	$T_2 C_1$
Control Group 2 ( $C_2$ )	No Pre-test	Teaching through structural approach	$T_2 C_2$

In this design check is provided for the equality of Experimental group and control group because there is provision of pre-test. The nature of the design is such that it controls most of the extraneous variables. The provision of the second control group ensures control interaction effect of Pre-test and treatment.

However, their design suffers with no control over any possible contemporary effect between (i)  $T_1 E$  and  $T_2 E$  (ii)  $T_1 C_1$  and  $T_2 C_1$ .

DESIGN NO. 7 : The Randomized Solomon Four Group Design

Randomly Assigned	Pre-test	Independent Variable	Post-test
Experimental group (E)	$T_1 E$	Teaching through Structural approach	$T_2 E$
Control group 1 ( $C_1$ )	$T_1 C_1$	Teaching through conventional method	$T_2 C_1$
Control group 2 ( $C_2$ )	No Pre-test	Teaching through Structural approach	$T_2 C_2$
Control group 3 ( $C_3$ )	No Pre-test	Teaching through Conventional method	$T_2 C_3$

In this stage check is provided for equality of Experimental group and control group 1 because there is provision of pre-test. The nature of the design is such that it controls most of the extraneous variables. The provision of the second control ensures control interaction effect of pre-test and treatment. The design controls any possible contemporary effects between pre-test and post-test. The results in this design provide greater confidence.

However this design is such that it is difficult to conduct in practical situation. There is a difficulty of statistical application in this design.

(C) *Factorial Design* : This design enables the experimenter to evaluate or manipulate two or more variables simultaneously in order to study the effects of number of independent factors singly as well as the effects due to interactions with one another.

*Design No.8 : Single Factorial Design of  $2 \times 2$*

There are 2 independent variables and each of the

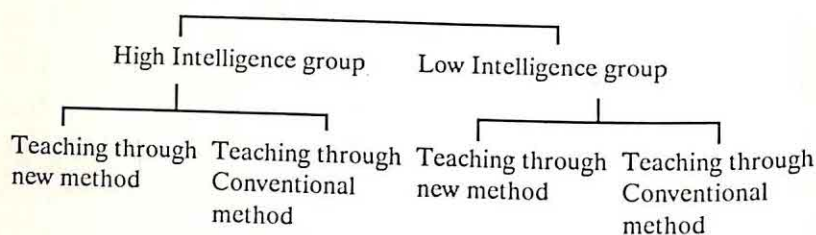
independent variables has two values. The first independent variable which is manipulated and has two values is called the experimental variable. The second independent variable which is divided into levels may be called control variable.

### *Two methods of teaching*

- (i) Teaching through conventional method
- (ii) Teaching through new method

### *Two levels of Intelligence*

- (i) High Intelligence group
- (ii) Low Intelligence group



**Example of a Factorial Design**

Intelligence Level	Method Conventional	Method New	Mean
High	76.00	74.00	75.00
Low	61.00	65.00	63.00
Mean	68.5	69.5	

12

Main effects      Difference between means of 2 methods = 1

Difference between means of 2 intelligence level = 12

In this example there is better achievement for low intelligence through new method and for high intelligence through conventional method.

In this design, the impact of more than one variable can be studied simultaneously. In this not only the significance of difference of different levels is studied but interaction effect can also be studied.

However, if too many variables and two many levels are studied, the experiment and statistical analysis becomes too difficult to manage.

## 6. Process of the Research Method

The following are the steps in the experimental research :

- (i) The research problem should be stated.
- (ii) It has to be determined whether the experimental method is appropriate for the research problem.
- (iii) It has to be specified that which independent variables are involved.
- (iv) The levels of the independent variable should also be specified.
- (v) The full range of potential dependent variables should be specified.
- (vi) The hypotheses are to be stated initially.
- (vii) It has to be determined whether measures for the potential dependent variables are available. It has also to be identified for which variables sufficiently reliable and valid measures exist and for which variables such measures do not exist but the researcher believes that they will be available to him for which either he will develop himself or take the help of others in their development. It has also to be identified for

which variables neither measures exist nor can be made available. In such case such variables are to be dropped from the research hypothesis.

- (viii) An initial estimate of the success potential of the research is to be made in terms of the possibility for establishing the levels of the independent variable. The same exercise is to be done for the dependent variable.
- (ix) It has also to be identified that what is the full range of intervening variables. It has also to be categorized that which such variables should be controlled, which such variables can be permitted to vary sympathetically, which intervening variables can be ignored and which can be left alone.
- (x) The research hypotheses are to be stated finally taking into consideration the practical difficulties involved in step no. VII, VIII and IX.
- (xi) The design of the experiment to test the hypotheses which have been finally stated. This can be done by establishing comparable experimental and control situations, the levels of independent variables, the needed conditions in which the intervening variables are to be handled and other sources of bias are to be controlled and the needed data collection for the dependent variable is to be made.
- (xii) Each researcher makes some assumptions in his research and works with certain limitations in research. The researcher should state those limitations and assumptions.
- (xiii) Final estimate of the success potential of the

research should be made on two issues. Firstly it should be checked if the design of the experiment was such that the independent variable will have full impact upon the dependent variable with proper control of extraneous variable. Secondly the outcomes of the research will meet the needs and goals of the researcher.

- (xiv) Implementation of experiment through collection of any pre-experimental measures and beginning of experimental and control conditions.
- (xv) The researcher should make periodic verification that integrity of experiment is being properly maintained.
- (xvi) Collection of any intermediate measures be made.
- (xvii) Termination of experiment through collection of post-experimental measures be made.
- (xviii) Data should be analysed to test hypotheses.
- (xix) The researcher should prepare the research report which should include findings, suggestions for remedy and recommendations of the areas for further research.

## QUESTIONS

- (1) *What do you mean by experimental method ? Describe.*
- (2) *What are the main elements of experimental method in educational research ? Discuss.*
- (3) *Discuss the features of experimental method.*
- (4) *What do you mean by internal validity ? How is it ensured ?*

- (5) *What do you mean by external validity ? How is it ensured ?*
- (6) *What do you mean by experimental design ? What factors are to be taken into account for the selection of experimental design ?*
- (7) *What is pre-experimental design ? Discuss the two designs which can be prepared in pre-experimental design ?*
- (8) *What is true-experimental design ? Discuss five designs which can be prepared in true-experimental design.*
- (9) *What is factorial design ? Discuss  $2 \times 2$  single factorial design in educational research.*
- (10) *Write the steps involved in the research through experimental method.*

## Educational Research Proposal

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### 1. Introduction

Each researcher has to write a research proposal before he undertakes any research work. For a new researcher it presents a great problem because he does not know the components of any research proposal. Even an experienced research worker is required to write a research proposal if he proposes to obtain financial assistance for a research project from any research organization. In our own country the NCERT, the UGC and ICSSR etc. have developed their own research formats but a few basic components are common to all well-prepared research proposals.

### 2. Title of the Proposal

The first part of any research proposal is its title. If

the title is not clearly stated it will not help the researcher in his work. A good title should clearly identify the research proposal and must clearly state about the following :

- (i) What variables are included in the research proposal ?
- (ii) What is the relationship between the different variables ?
- (iii) Which is the population to which the results may be generalized ?

While independent and dependent variables are stated in the research proposal title, which are of experimental nature, the variates and criterion variables are written in non-experimental studies. One example of each is given below :

#### *Experimental Study*

“The Effects of lecture method and text book method on the academic achievement in Economics of Class IX students”.

#### *Non-experimental Study*

“The Relationship between Socio-economic status and academic achievement in a foreign language of Class X students”.

In the experimental study the title of the research proposal is so stated that it shows the effect of independent variable upon dependent variable. This

type of title indicates which variable will be manipulated by the research and upon which variable its effect will be observed. In non-experimental study, the title should indicate the relationship between the variate and the criterion variable. In non-experimental study the variables are not manipulated, only relationship between variate and criterion variable is stated. In the above examples "Lecture method" and "Test book method" are independent variable and academic achievement is dependent variable. In the second example the "Socio-economic status is an example of variate and academic achievement is an example of criterion variable."

The boundaries should be identified for which the research findings may be generalized. They are generally expressed in the terms of "Target Population".

In the above examples, students of Class IX and students of Class X are target population in experimental and non-experimental population respectively.

Another requirement for a good, research title is that it should not be too lengthy. Attempts should not be made to answer all the questions relating to variables and the population in a title. Fifteen to twenty words are the maximum can be included in a research title.

Some good titles are given below :

1. A Comparison between two methods of teaching Algebra--Expository and Discovery--in the tenth class in a recognized secondary school.
2. The effects of grading on achievement in Mathematics.
3. The relationship between spelling, achievement and a personality factor.

4. A comparison of the Evaluation of Teacher performance by principals and teachers.
5. A study of the effect of Two seating arrangements in the foreign language achievement of Class VI.

### 3. Research Problem

The second part of any research proposal is the research problem. It is of special importance on account of its strategic location. The problem should define and delimit the specific area of the proposed research. It should begin with the general background of the problem and end with a specific statement of the problem. The research problem should be so structured that it should begin with a broad base of general problems and explanations. It should be followed by a survey of related research literature. It should end with the problem statement. The background of the research should identify the variables of the research problem, discuss the variables which are selected for the research study. Other important variables which are not included in the research study should also be briefly discussed. It should also be made clear that which criteria were used for the selection of the variables. This part of the research proposal should be written in simple language and should also be precised.

The significance of the problem should also be stated. It should meet the following requirements.

- (i) The research proposal is timely. Thrust areas of research change from time to time. Only such areas should be selected which are of crucial importance these days.

- (ii) The research proposal should be related with a practical problem. It should provide solution to any existing educational problem.
- (iii) The research problem should not have some a small target of population that its results cannot be verified.
- (iv) Target population of any research problem should be related to a popular population. For example the educational problems of minorities, scheduled castes, scheduled tribes, women and Handicapped children are considered significant there days in Indian educational research.

If the research proposal is to be submitted for financial assistance it should also be seen that what are the areas of priority of the finding agency. Each agency grants financial assistance to those research studies which it considers as central to its area of concern and others as peripheral.

The statement of the problem is the last stone in the pyramid of the research problem. It specifies the variate and criterion variables in non-experimental studies and independent and dependent variables in an experimental study, the type of relationship between variables and the target population. The following are the examples which satisfy the relationship criterion.

- (i) What is the effect of type of pronunciation drill on the pronunciation performance of class VI students in a foreign language teaching ?
- (ii) What is the relationship of a particular motivational device upon the learning performance of class IX students.

Another important criterion of a good problem statement is that it can be measured. A research problem in which the relationship between variables cannot be measured empirically cannot be categorised a research problem. The above two examples meet the criterion of measurement because in the first example it can be measured that what is the effect of pronunciation drill on pronunciation performance of class VI-students and in the second example the relationship of a particular motivational device can be measured upon the learning performance of class IX students.

The statement which seek to answer the questions of value-judgement should not be included in research problem. Such questions cannot be answered by a research study. For example the following questions/statements involve judgements and should be avoided in a research proposal.

- (i) Should moral education be based upon religions?
- (ii) Should the admissions in schools be made on Community reservation basis ?

The following are the examples which are objective and do not involve value judgement. Such statements should be included in a research proposal.

- (i) Do those students who get moral education show better character formation than those who do not get moral education ?
- (ii) The schools which make admissions on community reservation basis show poor academic performance than those who do not make admissions on the basis of community reservation.

#### 4. Statement of Hypothesis

The third part of a research proposal is statement of Hypotheses. It is done more sophisticatedly than the statement of problem. The research hypothesis is presented in an affirmative form rather than in the interrogation form. They state what is expected to occur if various conditions are evoked or presumed. The researcher should review the related literature thoroughly before formulating hypotheses.

Some examples of good hypotheses are given below :

- (i) There will be no significant difference between the performance score of students in Mathematics morning class and their performance score in evening class.
- (ii) There will be a significant positive correlation between the results of the test and the judgements of ability.
- (iii) There will be a difference in average fifth class Mathematics scores between students receiving 30 minute and those receiving 60 minute classes.

All the terms which are used in any hypothesis should be carefully defined. The hypothesis should be unambiguous and testable. Since the quantum of achievement is difficult to predict at the time of statement of hypothesis, researchers prefer "null hypothesis" which assumes that only a chance difference is expected to occur between the groups. A null hypothesis merely states that there is no relationship between the variables. It is expressed in statistical terms

$$X_A - X_B = 0$$

Suppose a researcher observed that Mr. X appeared to have better teacher-student relation than Mr. Y. It was observed that Mr. X used to discuss personal problems of the students and find out their solutions while Mr. Y used to have only formal relationship of classroom teaching. The researcher formulated the following problem.

“What are the effects of discussion of personal problems of the students on the teacher-student relationship” ?

The problem statement could be written as substantive hypothesis in the following words.

“The discussion of personal problems of the students will have better teacher-student relationship than not having any such discussion”.

This hypothesis can be written as null hypothesis in the following form :

“Discussion of personal problems of the students by the teachers with them and no discussion will have no differential effect upon the teacher-student relationship.”

The following criteria should be used for the formulation of testable and significant hypothesis :

- (i) The hypothesis must be clearly stated in operational terms.

- (ii) The hypothesis must be specific and testable.
- (iii) Research problems should be selected which are directly related to previous research or theoretical formulations.

## 5. Procedures

The fourth part of a research proposal is called procedures. It is also called "Methodology" and "Method of Procedure".

It comprises the following :

(i) *Target Population* : It is also called universe. The salient characteristics of the population should be thoroughly described so that it should be definite that what is the target population for which sample is to be drawn and to which the results of the study could be generalized.

(ii) *Sampling Plan* : The method of sampling and the rationale for the sampling method should be specified in the research proposal. If the sample is not thoroughly analysed and precisely described, faulty generalizations may be made. The sample should be made representative of the population. The sampling plan should also be described in the proposal. It should describe how the units in the target population will be selected and will controls will be used. A good sampling plan meets the following criteria :

- (a) obtaining or constructing an accurate, current list of the target population units.
- (b) Method of drawing the sample.
- (c) Number of subjects or populations units to be selected.

(iii) *Research Design* : The research design should indicate how the research setting will be arranged in order to yield the desired data with the least possible contamination by irrelevant variables. There is no single design that can be applied in all the cases. It depends upon individual researcher to devise his design. The design of educational research is never perfect. It represents a compromise on account of many practical considerations. But it should be specified in the research proposal what particular compromise has been proposed in the design. The design should ensure that answer of every hypothesis is provided in it.

A well prepared design should contain the following characteristics :

- (a) Specification of its relationship to each research hypothesis.
- (b) Description of the methods of proposed control of confounding variables and threats to validity.
- (c) Description of the design in statistical terms.
- (d) Identification of the types of inferences that may be made.

(iv) *Stimulus Materials* : It should also be specified in the research proposal that what stimulus materials will be used in the study. Kinds and ways of stimuli should be described. Most commonly used stimuli are printed instructional materials. Instructional materials should include the following elements :

- (a) Title
- (b) Author/Editor

- (c) Publisher
- (d) Year of publication
- (e) Intended population
- (f) Time required for administration
- (g) Cost of material

(v) *Response Measures* : The researcher should specify clearly what raw data are required by the research design and how they will be collected. Each instrument should be described including the following items of information :

- (a) Title
- (b) Author/Editor
- (c) Publisher
- (d) Population
- (e) Forms
- (f) Test objectives
- (g) Description of test, items, scoring procedures
- (h) Traits represented in score
- (i) Predictive/Concurrent validity
- (j) Reliability data
- (k) Normative data
- (l) Internal consistency of tests
- (m) Time required for administration
- (n) Cost of materials
- (o) Date of publication.

(vi) *Data Collection Methods* : The research proposal should identify the schedules and procedures to be used

for acquiring the data and recording it accurately. If they are lengthy, they should be placed in an appendix and reference be given in the body of the proposal.

(vii) *Data Analysis* : The researcher should specify how the data will be ordered and reduced to relate directly to the research problem. The statistical procedure to be used in the analysis of data should be described. It will be done hypothesis wise or not, it should be indicated in the research proposal. If a complex design or obscure statistical test is to be used, it should be indicated in the proposal.

If the research proposal is to be submitted to a Funding agency, the following information should also be provided in the research proposal :

*Logistics* : It consists of the following :

- (a) Time schedule
- (b) Personnel
- (c) Facilities, equipment and supplies
- (d) Travel expenses
- (e) Publication costs and other direct costs
- (f) Budget forms

The researcher should identify the funding agency such as

- (a) U.G.C.
- (b) I.C.S.S.R.
- (c) N.C.E.R.T.
- (d) S.C.E.R.T.S.
- (e) Universities

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The researcher should also obtain the research format from the funding agency and prepare research proposal on the guidelines provided by the funding agency.

### QUESTIONS

- (1) *What do you mean by educational research proposal ? What are its main elements ? Discuss.*
- (2) *What do you mean by title of the research problem ? Give examples.*
- (3) *What do you mean by research problem ? Discuss.*
- (4) *What do you mean by hypothesis ? Give some examples of good hypotheses.*
- (5) *Discuss the procedure of research proposal.*

## Data Collection

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### 1. Introduction

Every research problem involves the collection of data. Some people often equate process of data collection with research itself. The data collection has two aspects. In one aspect we include the technical component where we discuss why data are collected and how are collected. In the other aspect we consider a variety of tasks which are connected with successful and effective data collection.

There are two categories of data. The first one is primary data which is collected by the researcher himself. He can collect it either through observation or through experiment. The second one is secondary data which is much in common with literature searching.

## 2. Activities involved

There are certain activities which are common irrespective of the type of the problem taken for research. The data have to be located and arrangements have to be made for data collection. However, they must be collected and recorded in a form suitable for the intended analysis. The problem of adjustment may arise for errors and omissions and unusable data. The location of data is not easy and often may be unsure as to what his sources will be.

The collection of data requires time and substantial effort for acquiring skills and making the necessary arrangements for collection and to ensure adequate quality.

## 3. Access to Data

Generally it is a problem for researcher to get access to data because the institutions or the persons who generally control the data are not willing to provide him data for one or the other reason or excuse. Some necessary steps are required to motivate such institutions or persons to provide necessary data willingly. Some educational problems are of such nature that the subjects specially girls are not willing to disclose correct information. Similarly a researcher of any problem relating to public examinations of any board or university may not have access to confidential data.

## 4. Adequate Standard

The researcher should demonstrate that his data were properly collected. It is possible if the following conditions are fulfilled.

(i) It should be ensured that the supplied data met the requirement of validity. In other words the data should measure what they claimed to measure.

(ii) Proper attention should be paid to measurement error. The following types of error are possible in data collection :

- (a) error due to malfunctioning of measuring equipment
- (b) error of bias
- (c) deliberate falsehood
- (d) distortion of facts
- (e) random error

(iii) It should be ensured that a suitable sample was drawn out of the population so that proper generalisation could be made.

(iv) It should also be checked that the data were properly recorded. The conditions under which the data were gathered should be properly noted and suitable data recording method should be used. The efforts should be made to detect and eliminate errors arising during recording. The data are generally recorded in the following forms.

- (a) Notes of the researcher
- (b) Log books and journals are used by a researcher doing the experiment or conducting a field study
- (c) Interview notes
- (d) Responses to questionnaires
- (e) Recording on tape recorder
- (f) Video cameras
- (g) Transcribing data for computer input

#### 4. Data Organization

What ever method is used for collection of data it will be necessary that an extensive set of supplementary notes should be made for the following :

- (a) Sources of data
- (b) Conditions under which data were gathered.

There should be stored in such a way as offer some reasonable prospects of retrieval when required.

#### 5. Collecting Primary Data and Secondary Data

The primary data can be collected through laboratory measurement, field observation, questionnaire, interviews, opinionnaire etc.

The secondary data can be collected from technical publications such as manuals, handbooks, data sheets and standards, books and journals, official publications of the Central government, State governments, Local bodies and autonomous bodies, private data services and computer data bases.

#### 6. General Rules

There are some general rules that apply to all types of data collection. They are as follows :

- (i) Do not collect more information than is required for the research problem.
- (ii) Make sure the wording of the data collection instrument is clear and unambiguous.

- (iii) Use clear and explicit instructions in data collection instruments.
- (iv) Design the response options as carefully as the item stems themselves.
- (v) Make responding to the measuring instrument as alternative as possible.
- (vi) Make sure that the final products looks professional.

### QUESTIONS

- (1) *What are the methods of collection of data ? Describe.*
- (2) *What problems are involved in access to data ? Discuss.*
- (3) *Discuss the conditions which are necessary for proper data collection.*
- (4) *Discuss the general rules of data collection.*

## Data Analysis

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### 1. Definition

Data Analysis embraces a whole range of activities of both the qualitative and quantitative type. It is usual tendency in educational research that much use of quantitative analysis is made and statistical methods and techniques are employed. The statistical methods and techniques have got a special position in research because they provide answers to educational problems.

Kaul defines data analysis as “studying the organized material in order to discover inherent facts. The data are studied from as many angles as possible to explore the new facts”.

## 2. Purposes

The following are the main purposes of data analysis :

(i) *Description* : It involves a set of activities that are an essential first step in the development of most fields. A researcher must be able to identify a topic about which much was not known; he must be able to convince others about its importance and must be able to collect data.

(ii) *Construction of Measurement Scale* : The researcher should construct a measurement scale. All numbers generated by measuring instruments can be placed into one of four categories :

- (a) *Nominal* : The numbers serve as nothing more than labels. For example No. 1 was not less than No. 2. Similarly No. 2 was neither more than No. 1 and nor less than No. 3.
- (b) *Ordinal* : Such numbers are used to designate an ordering along some dimension such as from less to more, from small to large from sooner to later.
- (c) *Interval* : The interval provides more precised information than ordinal one. By this type of measurement the researcher can make exact and meaningful decision. For example if A, B and C are of 150 cm, 145 cm and 140 cm height, the researcher can say that A is 5 cm taller than B and B is 5 cm taller than C.
- (d) *Ratio Scale* : It has two unique characteristics. The intervals between points can be demonstrated to be precisely the same and the scale has a conceptually meaningful zero point.

(iii) *Generating empirical relationships* : Another purpose of analysis of data is identification of regularities and relationships among data. The researcher has no clear idea about the relationship which will be found from the collected data. If the data were available in details it will be easier to determine the relationship. The researcher can develop theories if he is able to recognize pattern and order of data. The pattern may be showing association among variables, which may be done by calculating correlation among variables or showing order, precedence or priority. The derivation of empirical laws may be made in the form of simple equations relating one interval or ratio scaled variable to a few others through graphed methods.

(iv) *Explanation and prediction* : Generally knowledge and research are equated with the identification of causal relationships and all research activities are directed to it. But in many fields the research has not been developed to the level where causal explanation is possible or valid predictions can be made. In such a situation explanation and prediction is construct as enabling the values of one set of variables to be derived given the values of another.

#### 4. Functions

The following are the main functions of data analysis :

- (i) The researcher should analyse the available data for examining the statement of the problem.
- (ii) The researcher should analyse the available data for examining each hypothesis of the problem.

- (iii) The researcher should study the original records of the data before data analysis.
- (iv) The researcher should analyse the data for thinking about the research problem in lay man's term.
- (v) The researcher should analyse the data by attacking it through statistical calculations.
- (vi) The researcher should think in term of significant tables that the available data permit for the analysis of data.

## 5. Statistical Calculations

The researcher will have to use either descriptive statistics or inferential statistics for the purpose of the analysis.

(i) The descriptive statistics may be on any of the following forms :

- (a) Measures of Central Tendency : These measures are mean, mode, median, geometric mean and harmonic mean. In educational statistics the last two measures are not used. Which of the first three will be used in educational statistics depends upon the nature of the problem.
- (b) Measures of Variability : These measures are range, mean deviation, quartile deviation and standard deviation. In educational statistics the first two measures are rarely used. The use of standard deviation is very frequently made for the purpose of analysis.
- (c) Measures of relative position : These measures

are standard scores (Z or T Scores), Percentiles and percentile ranks. All of them are used in educational statistics for data analysis.

- (d) Measures of relationship : These measures are Co-efficient of Correlation partial Correlation and Multiple Correlation. All of them are used in educational statistics for the analysis of data. However the use of rank method is made more in comparison to Karl pearson method.

(ii) The inferential statistics may be in any one of the following forms.

- (a) Significance of difference between means : It is used to determine whether a true difference exists between population means of two samples.
- (b) Analysis of Variance : The Z and t tests are used to determine whether there was any significant difference between the means of two random samples. The F test enables the researcher to determine whether the sample means differ from one another to a greater extent than the test scores differ from their own sample means using the F ratio.
- (c) Analysis of Co-variance : It is an extension of analysis of variance to test the significance of difference between means of final experimental data by taking into account the Correlation between the dependent variable and one or more Co-variates or partment control variables and by adjusting initial mean difference in the group.
- (d) Correlation methods : Either of two methods of Correlation can be used for the purpose of calculating the significance of the difference between Co-efficients of Correlation.

- (e) **Chi Square Test** : It is used to estimate the likelihood that some factor other than chance accounts for the observed relationship. In this test the expected frequency and observed frequency are used for evaluating Chi Square.

The details about the formula and calculation can be studied in any guide book on educational statistics.

### QUESTIONS

- (1) *What do you mean by analysis of data ? Discuss.*
- (2) *Discuss the purposes of analysis of data.*
- (3) *What are the main functions of analysis of data ? Discuss.*
- (4) *Write the forms of descriptive statistics.*
- (5) *Write the forms of inferential statistics.*

## Interpretation of Data

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### 1. Meaning

According to F.L. Whitney, Interpretation means an adequate exposition of the true meaning of the material presented in terms of the purposes of the study being reported and of the chapter and section topic involved.

### 2. Purposes

The following are the main purposes of interpretation of data or results :

- (i) To throw light on the real significance of the material in the context.
- (ii) To understand implications of the data.

- (iii) To provide hints of conclusions and recommendations of the researcher.
- (iv) To show the values of greatest worth that have resulted from the research.
- (v) To refer important generalizations.

### 3. Factors

The researcher should keep the following factors in consideration in interpretation of data :

- (i) Not to ignore those factors which are unstudied :

In educational research, there are many factors which have their impact upon the findings of the research but no researcher is in the position to study all the factors. Naturally he does not take into account in interpretation of the results those factors which have not been studied. It has its effect upon the search of truth. Thus the researcher should take into consideration such factors in his interpretation. For example if a comparison has been made between the traditional method of teaching and any modern method of teaching in respect of effectiveness of teaching, the interpretation that successful attainment is the result of method of teaching only is complete denial of the role of general mental ability, high achievement motivation and better study habits etc.

- (ii) Not to ignore those factors which have not been selected for study :

In educational research, the subjects are generally so large that the researcher collects the data from a

selected group only. The researcher should remember that some factors which have not been included in the selective group are equally important in their impact upon findings. For example if the researcher collects data from a particular school in a particular area and then he concludes about all the schools.

(iii) Not to over-interpret the expected results :

The researcher should remember that even if he finds the findings of the research as per his expectations he should not interpret more than what can be interpreted on the basis of data available. The researcher should be cautious that he reports all such factors which might be responsible for the findings.

(iv) Not to exercise defence mechanism in interpreting the results :

The researcher should remember that it is not necessary that the hypotheses should always be confirmed. It is possible that the researcher may exercise defence mechanism if the results of the study are not found as per expectations of the research. In such a situation he should not try to find faults in tools or samples for the results against his expectations. If any researcher tries to do so, his interpretation will not be considered fair. The hypotheses are made in the beginning of the research when the knowledge of the researcher about the problem is very limited. Agreement between the tentative and the results is not necessary.

## QUESTIONS

- (1) *What do you mean by interpretation of data ? Discuss.*
- (2) *What are the main purposes of interpretation of data ? Discuss.*
- (3) *What factors are to be taken into consideration while interpreting the data ? Discuss.*

## Research Report

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### 1. Meaning

A detailed account of the research experience from selection and definition of the problem, formulation of hypotheses, gathering, analysing and interpreting data, testing of hypotheses, making conclusion and suggesting further research in the related problem area is called a research report.

### 2. Components

The basic components of a research report are as follows :

- (i) Introduction of the research problem : The researcher will write in it :

- (a) What is the problem ?
  - (b) What is its importance ?
  - (c) What is the relation of the problem with previous theory and research,
  - (d) What are the objectives of the study ?
  - (e) What are the hypotheses ?
- (ii) Description of the procedure of the research.  
The researcher will write in it :
- (a) How did he select the subjects ?
  - (b) How many subjects were used ?
  - (c) How were the subjects assigned to groups ?
  - (d) What was done to the subjects ?
  - (e) How was it done ?
  - (f) When was it done ?
  - (g) How long was it done ?
  - (h) How was the reliability of the measuring instruments measured ?
  - (i) How was the validity of the measuring instruments measured ?
- (iii) Description and presentation of the results : The researcher will write in it :
- (a) Which statistical procedures he used to test the hypotheses ?
  - (b) What were the outcomes of those procedures ?
  - (c) What were the subsidiary findings of the research ?

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- (iv) Discussion of the study findings : The researcher will write in it :
- (a) Why did the results manifest themselves in a particular way ?
  - (b) What did there results signify ?
  - (c) What was the relationship between this research and the previous research upon which it was based ?

### 3. Features

The following are the essential features of a good research report :

- (i) Clarity
- (ii) Conciseness
- (iii) Veracity
- (iv) No place for figures of speech, lyrical prose and am using anecdotes
- (v) No lengthy digressions
- (vi) Only necessary details
- (vii) Absolute uncompromising honesty
- (viii) Serious attempt and not a game.

### 4. Reasons for Writing

The following are the main reasons on account of which the researcher should write the research report.

- (i) It is a logical conclusion of doing the research.

- (ii) It enriches the curriculum vital of the researcher which helps him in appointment and promotion.
- (iii) Writing of the research report is an easy task and it is not that difficult as understood.

## 5. Mode of Communications

The researcher may use any of the following mode for communicating his research results :

(i) *A research monograph* : The researcher may publish a research monograph on the basis of his research results through a research journal or a reputed research publisher. But this mode of communication is generally used for large scale studies. Acceptance for publishing the research paper in the monograph depends upon the standard of the research work and the reputation of the researcher.

(ii) *A research journal* : The researcher may publish a research paper in a reputed research journal. But this requires that the paper should be acceptable to the Editor of the journal. The prestigious journals send these papers to reviewers who are conversant with the research area in which the research paper has been written.

(iii) *Presenting in the meeting of the Association/Society/Congress* : There are annual conferences of the associations, societies and Congress in each subject area. They provide opportunities to the researchers to present their research results in the form of a research paper before the members of the association or the society or the delegates of the Congress which are followed by the discussions. The journals of those organizations publish

these papers in the form of the proceedings of the Association/Society/Congress.

## 6. Format

The research reports is divided into the following parts :

(a) Preliminary Section : It consists of the following :

- (i) Title Page
- (ii) Preface
- (iii) Table of Contents
- (iv) List of tables
- (v) List of figures, maps and illustrations

(b) Introduction : It consists of the following :

- (i) Importance of the problem under investigation
- (ii) A review of related literature
- (iii) Statement of Hypotheses or relationships being studied
- (iv) Delimitations of the study
- (v) Assumptions of the study
- (vi) Definition of important terms

(c) Methods : It consists of the following :

- (i) How was the study conducted ?
- (ii) From which population was the sample selected ?

- (iii) How many subjects were selected ?
  - (iv) What were the demographic characteristics of the subjects ? (male/female, average age)
  - (v) Was there any characteristic which make the sample a typical to the population ?
  - (vi) How were the subjects assigned to groups ?
  - (vii) What instructions were given to the subjects ?
  - (viii) How conditions were controlled ?
  - (ix) What was the treatment of variables ?
  - (x) How, when and on what were subjects measured ?
  - (xi) What data collection instruments were used ?
  - (xii) What was the format of items ?
  - (xiii) What was the reliability of the instrument ?
  - (xiv) What was the validity of the instrument ?
  - (xv) What are the details of the instrument which was prepared by the researcher ?
- (d) Results : It consists of the following :
- (i) What statistical procedure was used to study the hypotheses ?
  - (ii) What was the probability level of each hypotheses test ?
  - (iii) What was the probability level of each statistics ?
  - (iv) What was the attendant degree of freedom ?
  - (v) What was the strength of the relationship of the variables ?

- (vi) What were the group means and standard deviation ?
  - (vii) What were the principal findings ?
- (e) Discussion : It consists of the following :
- (i) What were the original purposes of the study ?
  - (ii) How were these purpose met ?
  - (iii) Why the obtained occurred ?
  - (iv) What were the conclusions of the researcher for practice, theory and future research ?
  - (v) What is the contribution of the study to the research literature ?
  - (vi) What are the strengths and weaknesses of the study ?
- (f) Reference Section : It consists of the following :
- (i) Bibliography
  - (ii) Appendices : Questionnaires, Copies of letters used, evaluation sheets, checklists etc.

## QUESTIONS

- (1) *Discuss the meaning of research report.*
- (2) *Discuss the basic components of a research report.*
- (3) *Describe the essential features of a good research report.*
- (4) *What are the modes of communication of the research results ?*
- (5) *Describe the format of a good research report.*

# Index

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## A

access to data 139

## C

complex factorial design  
  experimental variable 81, 83,  
  84

  meaning 79

  procedure 80

Cook, P.M. 2

Crawford, G.C. 3

## D

data

--analysis,

  definition 143

functions 145

purposes 144

  description 144

  explanation and prediction  
  145

  generating empirical  
  relationships 145

  measurement scale

    construction 144

    interval 144

    nominal 144

    ordinal 144

    ratio scale 144

  statistical calculations 146

Chi-square test 148

correlation methods 147

co-variance analysis 147

difference between means

  significance 147

- measures of
    - central tendency 146
    - relationship 147
    - relative position 146
    - variability 146
    - variance analysis 147
  - collection,
    - access to data 139
    - adequate standard 139
    - activities involved 139
    - data organization 141
    - general rules 141
  - interpretation,
    - factors 150
    - meaning 149
    - purposes 149
  - organization 141
  - Daten, Van 99
  - descriptive method *see*
    - survey method
  - devising alternative 9
  - directional hypothesis 25
- E
- educational research,
    - classification 87
    - complex factorial design 79
    - data
      - analysis 143
      - collection 138
      - interpretation 149
    - descriptive survey method 96
    - experimental and control groups 62
    - experimental method 110
    - experimental/non-experimental 58
    - extraneous variables 36
    - factors affecting significance level 53
    - features 6
    - historical method 91
    - hypotheses 23
    - inductive and deductive methods 15
    - meaning 1
    - methods 86
    - proposal 125
    - purposes 4
    - report 153
    - sampling
      - errors 45
      - techniques 26
    - scientific methodology 8
    - simple
      - factorial design 70
      - randomized design 65
    - stratified sampling 31
    - variables 18
  - experimental method 89
    - definition 110
    - elements 110
      - control 110
        - degree 111
        - methods 111
        - purpose 110
      - manipulation 112
      - observation 112
      - replication 112
    - experimental design 115
      - factorial 119
      - pre 115
      - true 116
    - experimental validity 113
      - external 114
      - internal 113
    - features 113
    - research process 121
  - experimental research 59
  - extraneous variables 21
    - control 38

homogeneity 39

meaning 36

procedure 44

K

Kaul 143

F

M

factorial design 120

faith vs. scientific methods 8

G

Good, Caster V. 4, 11

Guilford 104

H

historical method 88

external criticism 93

internal criticism 93

meaning 91

negative arguments 92

positive arguments 91

primary sources 92

process in research 94

secondary sources 93

Howard 3

Hutcheris 2

hypothesis,

meaning of 23

statement 131

I

ICSSR 125, 136

independent variable effect of  
20inductive/deductive process use  
of 17

intelligence,

levels of 120

Mander, A.E. 11

mean academic achievement  
score 39

Monly, Georg G. 3

Monroes, W.S. 3

N

NCERT 125, 136

non-directional hypothesis 25

non-experimental research 58

O

observation,

number of 16

obtaining knowledge,

methods of 11

appeal to authority 11

common sense 11

intuition and revelation 12

rationalism 12

organismic variable 21

P

population 26

post-test design 115, 116, 117

prediction vs. explanation 10

pre-test design 115, 117

primary data collection 141

probability level 49

## R

- randomized groups 117
  - randomized solomon
    - four group design 119
    - three group design 118
  - randomized subject 116, 117
  - random sampling 28
  - representative observation 16
  - research problem 128
  - research problem 133
    - data analysis 136
    - data collection methods 136
    - design 134
    - response measures 135
    - sampling plan 133
    - stimulus material 134
    - target population 133
  - research proposal,
    - title of 125
  - research report,
    - communication mode 156
    - presenting in the meeting 156
    - research journal 156
    - research monograph 156
  - components 153
  - features 155
  - format 157
  - meaning 153
  - reasons for writing 155
- Rummel, J. Francis 2

## S

- sample 27
- sampling error,
  - types of 51
- Sax Gilbert 4
- science,
  - characteristics of 13

- empiricism 13
- quest for precision 13
- reduction and bias control 13
- theory construction 14
- verification 13

- secondary data collection 141
- sharp 3
- significance level,
  - factors 54
- simple factorial design,
  - experimental variable 71, 77
  - meaning 70
  - treatment 75
  - graphic representation 75
- training 72
  - graphic representation 74
- simple randomized design 65
  - post-testing 65
  - pre-testing 65
  - procedure 67
  - steps 65
  - two groups 66
- statistical inference 46
- static design 116
- stratified sampling,
  - meaning 31
  - procedure 32
- survey method 88
  - nature 96
  - process of research 107
  - purposes 97
  - types 97

## T

- teachers,
  - stratification of
    - basis of age 32
    - population 33
    - sample 34

teaching,

methods of 120

Travers, Robert M.W. 4, 11

type-writing production 68

V

variables,

kinds of 19

U

UGC 125, 136

W

writing,

reasons for 155



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